Knowledge.

With which is incorporated Hardwicke's Science Gossip, and the Illustrated Scientific News.

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Conducted by Wilfred Mark Webb, F.L.S., and E. S. Grew, M.A.

APRIL, 1914.

ASTRONOMY AND MODERN NOVELISTS.

By PHILIP H. LING, M.Sc.

JULES VERNE.

Of all the sciences astronomy is that which appeals most to the imagination, and it might have been expected that it would accordingly be much favoured by poets and novelists. This is not the case. Comparatively few authors have cared to introduce astronomical ideas into their works, and this for two very sufficient reasons, for the general public takes very little interest in the subject, and the novelist who bases his plot upon it runs some risk of becoming unintelligible to the majority of his readers; and, in the second place, astronomy dealing largely with the Universe outside the Earth, it is a matter of considerable difficulty to use it in connection with merely human characters.

But, whereas the novelist may, with some trouble, introduce the external Universe into his work, it seems to have been overlooked that he may possibly by that means be making a serious contribution to astronomical science. His work is the work of the imagination, and it is conceivable that he may succeed in penetrating further into the secrets of the Universe than the more orthodox man of science. At all events, his suggestions may be entitled to serious consideration.

Of the few who have attempted to write what we may call the astronomical novel perhaps the most famous is the late M. Jules Verne, an author whose works were the delight of generations of boys, and who has, with some injustice, been rather slighted by their elders. He was not a man of science, which is equivalent to saying that his statements are not invariably marked with scientific clearness. But as has been often pointed out, he succeeded, in some cases, in forecasting advances in various branches of science with an accuracy which is absolutely startling. The submarine vessel in "Vingt Mille Lieues sous les Mers" is a case in point; and there is another remarkable instance mentioned in the present paper.

M. Verne wrote five books more or less connected with astronomy. The first two, "De la Terre à la Lune" and "Autour de la Lune," form practically one work, published in 1865. We are here introduced to a group of Americans of a most enterprising type. The Gun Club, of Baltimore, having lost its occupation at the close of the Civil War, determines to fire a projectile to the Moon. The cannon is a cylindrical hole in the ground, suitably lined, and the projectile is hollow, so as to carry passengers. Three men take their places in it, and the gun is fired by means of a large charge of gun-cotton powerful enough to send it out of reach of the Earth's attraction. The projectile, however, misses its mark, and, after rotating round the Moon, falls back into the Pacific Ocean.

The curve described by M. Verne's bullet raises some very interesting questions. It begins and ends on the Earth, and is therefore what is now called a "closed orbit of ejection." A particle projected from the Earth, and subject only to its attraction, would, of course, describe such an orbit; but under the simultaneous influence of the Earth and the

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Moon the existence of such orbits is by no means obvious. They appear to have been first mentioned by Burrau,* who examined some particular cases. Sir G. H. Darwin† also pointed out certain examples. It is only quite recently, however, that the general theory has been discussed by Professor F. R. Moulton,‡ who has proved the existence of such orbits in the restricted problem of three bodies, and found the initial conditions necessary. M. Verne seems to have forestalled these investigators by a considerable interval of time, and it is only fair that some credit should be assigned to him. His excursions into the theory are unfortunately not very clear. He says there was a miscalculation in the case of the initial velocity of the projectile, which rendered it too large; but the cause of the failure to strike the Moon was a close approach to a mysterious asteroid—of which more presently—so that his orbit of ejection is really a case of the problem of four bodies. So far as can be made out, it appears to be a figure-of-eight orbit, with the Earth at the end of one loop and the Moon just inside the other. Whether such an orbit is actually possible has not yet, I believe, been ascertained.

Many years later M. Verne wrote a sequel, entitled "Sans dessus dessous," which appeared in the *Boy's Own Paper* (1890) as "Barbicane and Co.," and was reprinted as "The Purchase of the North Pole." The same characters, wishing to reach some hypothetical coalfields at the North Pole, conceive the idea of displacing the axis of the Earth by means of a violent shock administered by firing off a gigantic cannon. The mathematician employed, however, makes a mistake in the calculations, and the experiment not only fails, but is proved to be impossible.

An earlier work was "Hector Servadac" (1877), one of the author's wildest ventures. A comet collides with the Earth, and carries off a part of it, together with those persons who happen to be on the spot at the time. It is unlike other comets in being a compact solid body, which consists of an alloy of gold and tellurium; and its periodic time is exactly two years, so that a second collision occurs and deposits the travellers neatly back on the Earth. It will be seen that the story is by no means well constructed; indeed, some critics have marked it as the beginning of decadence in M. Verne's work. But it contains a considerable amount of information, and is never wanting in interest.

The fifth of the astronomical novels is "La Chasse au Météore," one of the author's last books. The central idea is that of a large meteor describing a closed curve round the Earth. It consists of pure gold, thus, to some extent, resembling Hector Servadac's comet Gallia; and an ingenious Frenchman, by means of a mysterious machine which he has invented, succeeds in bringing it down to Earth.

The suggestion of a second satellite to the Earth is one of which M. Verne seems very fond. Twice in his books—once in "Les Cinq Cents Millions de la Bégum," and once in "Sans dessus dessous"—terrestrial projectiles assume permanent orbits round the Earth; and twice—once in "Autour de la Lune" and once in "La Chasse au Météore"—the question of an actual satellite arises. In "Autour de la Lune" the idea is attributed to "a French astronomer, M. Petit," who determined the existence of the body, and its period, from certain perturbations. If this is a genuine reference, the suggestion is one which has now been forgotten. The existence of such a satellite is not, of course, impossible, although the method of deducing it from the unexplained motion of the Moon is entirely out of the question.

M. Verne's contributions to astronomy appear, then, to be: (i) A suggestion of the existence of closed orbits of ejection; (ii) a method of approaching the Moon by means of a projectile; (iii) the idea of a second satellite to the Earth. For the last he does not claim the credit, and there is no actual evidence in its support. But the projectile method, unpractical as it looks, is of much interest. If the orbit mentioned exists and is stable, and if the initial velocity could be adjusted so as to secure exact motion in this curve, then there would be little risk of any harm coming to the projectile. The chief danger would arise from heat, due to friction with our own atmosphere, and from the final fall on the Earth. If, finally—"there is much virtue in 'if'"—the means of attaining a sufficiently high velocity were known, the problem would come within the range of the possible. It is to be supposed that it will sooner or later present itself to humanity, if only as a result of over-population. Meanwhile, speculative as it is, it need not be dismissed as devoid of interest.

* "Recherches numériques concernant des solutions périodiques d'un cas spécial du problème des trois corps." *Astronomische Nachrichten*, CXXXV, CXXXVI (1894).

† "On Certain Families of Periodic Orbits," *Monthly Notices, Roy. Astro. Soc.*, LXX (Dec. 1909).

‡ "Closed Orbits of Ejection and Related Periodic Orbits," *Proc. Lond. Math. Soc.*, XI (June, 1912).

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STONYHURST COLLEGE OBSERVATORY.

We have received the report of this busy observatory for 1913 from its Director, the Rev. Walter Sidgreaves, S.J., F.R.A.S. Meteorological and magnetical records loom largely in its work. We are told that the past year has been "remarkably mild and cloudy," with "no excessive heat and no great cold." On sixteen days the shade temperature reached, or exceeded, 70°, but once only, on August 3rd, did it reach 76°. The lowest record of temperature was made on December 31st, when the thermometer marked 21°. The excessive cloudiness of the year was shown by the Stokes Sunshine Recorder, registering three hundred hours less than the average of the past thirty-three years. The rainfall of the first three months was 6·5 inches above the average, but in the four from July to October there was a deficit of 10·5 inches, with the result that the total fall for the year was five inches short of the mean record. The greatest fall on any day in April during sixty-six years occurred on the 26th, when 1·180 inches were recorded. The total length of air crossing the Observatory during the year was one thousand two hundred and thirty-two miles below the average of eighty-six thousand five hundred and eighty-five miles. During July only four thousand five hundred and seventy-seven miles were registered, as against eight thousand two hundred and eighty-eight miles in 1877—both years holding a record for July. Last November holds the record for the past sixty-six years for the number of days—no fewer than twenty-eight—on which rain fell to the amount of ·005 inch or more.

The magnetic record on one hundred and thirty days was *calm*; on two hundred and six there was a very *small* amount of disturbance; on twenty-three it is marked *moderate*; but only once, on April 9th, was the disturbance sufficient to be marked *great*, and none with *very great*. No records are given for five dates.

The Sun was observed on two hundred days, on twenty-five of which spots and faculae were drawn, and on nineteen only faculae. This means that on 87·5 % of the observing days there were no dark spots. "The mean disc area of the spots (in units of $\frac{1}{5000}$th of the visible surface) appears at 0·04; and the mean daily range of magnetic Declination (in minutes of arc) at 9′·7."

These compared with the means of the past five years are :—

Year	...	1908	1909	1910	1911	1912	1913
Spot area	...	4°·6	3°·8	1°·8	0°·33	0°·22	0°·04
Declination range		14°·1	13°·5	14°·5	12°·6	8°·1	9°·7

This is the lowest mean disc area observed since the tabulations were commenced in 1898. The cloudy weather has militated against making solar or stellar spectrographs. The Observatory is now furnished with a wireless equipment, as well as with a seismological pendulum.

Frank C. Dennett.

SOLAR DISTURBANCES DURING FEBRUARY, 1914.

By FRANK C. DENNETT.

The weather during February was far from favourable for the telescopist, but it was found possible to observe the Sun every day with the exception of the 19th. Spots were seen on eight days (2nd to 7th, 18th, and 28th), faculae only on six (1st, 11th, 14th, 23rd, 24th, and 27th, whilst on the remaining twelve days the disc appeared free from disturbance. The longitude of the central meridian at noon on February 1st was 180° 27′.

No. 1.—First seen a little past the central meridian on February 2nd. The western spot or leader was largest, whilst behind it, and slightly more to the south, was a second spotlet with some pores on the eastern side; during the day its appearance altered somewhat. Slight alterations took place each day. On the 5th the leader contained two umbrae, and two pores preceded it. On the 6th and morning of the 7th the two larger components were still visible imbedded in faculae, but later, although the faculic disturbance was visible, the spots were gone. When the slit of the spectroscope was placed across the group on the 3rd, 4th, and 5th the C-line showed small but well-marked disturbances, being displaced both ways slightly, and containing small reversals and dark hydrogen flocculi, whilst on the 5th the dark D_3 line of helium was visible. The leader was over five thousand miles in diameter, and the maximum length attained was fifty-six thousand miles.

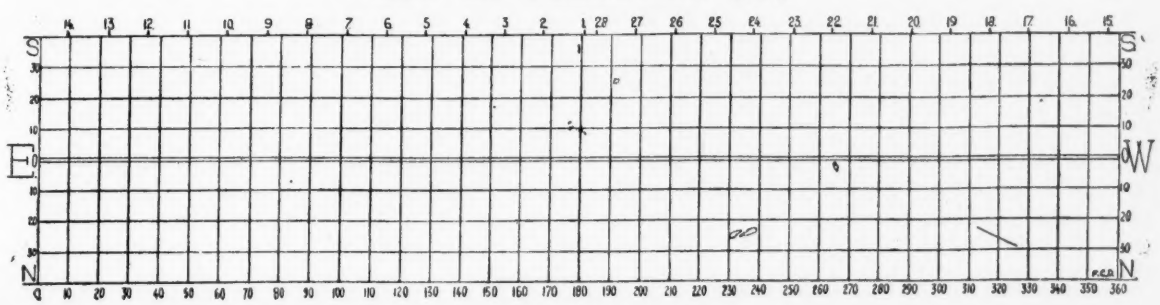
On the 18th there was one tiny black pore in the northern hemisphere. On the chart a line will be seen joining longitude 313°, latitude 23°, and 326°·5, 29°. The pore must have been upon that line, but clouds effectually intervened and prevented the completion of the requisite measures.

On the 28th there were one or two minute pores, too small for exact measurement of position, in the south-eastern quadrant.

Faculic disturbances were visible in the northern hemisphere on February 1st, between longitudes 230° and 239°. There was a faculic area on the 11th in the south-eastern quadrant. A small facula on the 14th was very near to the South Pole. On the 23rd, at about longitude 191°, S. latitude 26°, there was a faculic knot, and also some within the eastern limb on the 24th. Some small bright spots were nearing the western limb on the 27th and 28th, situated about longitude 265°, N. latitude 1° to 3°.

Our chart is constructed from the combined observations of Messrs. J. McHarg, E. E. Peacock, J. C. Simpson, C. Frooms, and the writer.

DAY OF FEBRUARY, 1914.



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SPORE DISPERSAL IN THE LARGER FUNGI.

By SOMERVILLE HASTINGS, M.S., F.R.C.S.

(With illustrations from photographs by the writer.)

(Continued from page 103).

It is in those genera which assume the umbrella or shelf-like form that the best adaptations for the increase of spore-bearing surface are seen; and in these the sporogenous tissue is in all cases directed downward. In *Hydnum* (see Figures 95 and 102) we find the increase of surface by means of spines. *Hydnum erinaceum* is a large and beautiful form which grows from the interior of hollow trees. In the toadstools proper, the most successful of the larger fungi, the increase of surface is by means of folds or gills. In some forms, such as *Cantarellus* (see Figure 103), these folds are shallow and branched; but in most they take the form of thin plates closely packed together. In some of these, e.g., *Russula nigricans*, practically all the gills are of the same length, so that toward the margin large spaces exist between them. In this way an increase of surface area by six or seven times is obtained. But in most toadstools (see Figure 106) gills of various lengths are seen, and all the available space is filled. In the mushroom (*Psalliota campestris*), for example, an increase of area by twenty times is thus obtained, and in this fungus the least space between any two gills has been shown to be 0·2 millimetre, or double the distance that the spores are shot out horizontally before falling downward. This minimal distance of separation may be thought to indicate an unnecessary degree of caution on the part of Nature, as a little more than half this distance would do as well. But it has to be remembered that sometimes the stalk of a toadstool is displaced so that its cap is no longer horizontal; and though in such cases, as will be shown later (page 127), the gills usually at once respond, and again take up a vertical position, nevertheless the distance between any two will be of necessity decreased. In *Boletus* and *Polyporus* (see Figures 104 and 107, and 76 and 78) the gills of the toadstool are replaced by tubes, and in *Polyporus squamosus* (see Figure 76) an increase of eleven or twelve times the spore-bearing surface is by this means obtained. The genus *Fomes* (see Figure 105), which grows on trees, closely resembles *Polyporus*, except that its fruit (for the fungus plant is within the tree) is of firmer and more woody consistence, and lasts from year to year, producing a fresh growth of tubes annually. In this way very long tubes are formed, and the increase of spore-bearing surface for a specimen which had grown for twenty-five years was found to be no less than nine hundred and forty-two. But with long, fine tubes an absolutely vertical position is essential, else the spores in falling would strike and adhere to the sides. This is attained by the firm woody form and the broad base of attachment to the supporting tree.

The small size of the spaces between the gills of most toadstools (Agarics), or within the tubes of Polypori and Boleti, makes it essential that both should be maintained in an absolutely vertical position. Otherwise many of the spores, in falling vertically, would strike and adhere to the side walls, and become of no further use for purposes of reproduction. In the mushroom, for example, a tilt of anything beyond 2° 30′ will prevent some of the spores from falling free of the gills; and, although some of the gills will not be affected at all by a tilt of even 45° or more (see Figure 109), half the spores from others will be lost by a tilt of even 5°, and four-fifths by a tilt of 9° 30′. For this reason toadstools are, as a rule, very rigid, being hardly at all affected by wind, and are in consequence among the easiest of living objects to photograph. This rigidity is attained by a stalk, which is firmly implanted in the ground, and is either solid, hollow, or provided with an external fibrous layer. In most cases (see Figure 110) the cap is firmly attached to the stem, and no doubt the value to the plant of the firm fleshy tissue of which both are often composed is more for the maintenance of rigidity than for the nourishment of parasites that are liable to impair this (see page 101). In *Coprinus comatus* (see Figure 110) the attachment of the cap to the stem is less firm; but here, owing to the bell-like shape of the cap, its centre of gravity is well below the point of attachment of the stalk, and the result is that, even if the stem be tilted through several degrees, the vertical position of the cap is maintained. In the Parasol toadstool (*Lepiota procera*) (see Figure 108) the point of union between stem and cap is also high, but the attachment is much firmer.

As will be seen from the above, it is of the utmost importance to the toadstool that the cap should be kept absolutely horizontal and the gills vertical; and if anything should interfere with this position the toadstool, if immature, at once makes an attempt to rectify it by curvature of the stalk. We must all have noted the curved stems of toad-

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FIGURE 102. *Hydnum erinaceum* grows from the interior of hollow trees.

FIGURE 103. *Cantarellus tubaeformis* with shallow depressions between the branched gills.

FIGURE 104. *Boletus bovinus.* A toadstool with vertical tubes on the lower surface of the cap.

FIGURE 105. *Fomes fomentarius.* A fungus that goes on growing from year to year. It is a destructive parasite to forest trees.

FIGURE 106. Under surface of *Lactarius subdulcis* showing all the available space that is filled in by gills of various lengths.

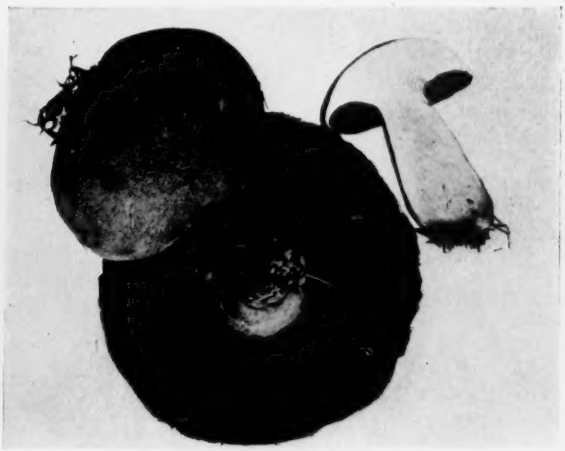

FIGURE 107. *Boletus badius* showing upper and lower surfaces of cap and a small specimen in section.

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FIGURE 108. The Parasol Toadstool (*Lepiota procera*).

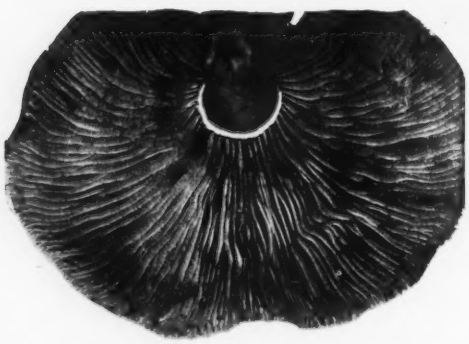

FIGURE 109. A specimen of *Tricholoma rutilans* which had been standing on its side for 18 hours.

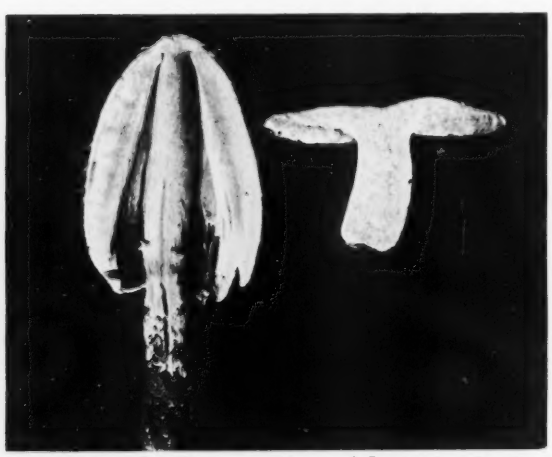

FIGURE 110. *Coprinus comatus* and *Lactarius fragilis* in section to show the stems and caps.

FIGURE 111. A not quite mature specimen of *Amanita mappa* which had lain on a flat surface for 16 hours. The curving of the stem to return the cap to a horizontal position is seen

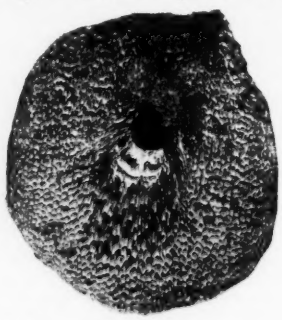

FIGURE 112. A specimen of *Boletus chrysenteron*, growing out from the side of a bank, showing how the tubes have grown downward.

FIGURE 113. A curious growth of a woody fungus found within the interior of a hollow tree.

stools growing from the side of a bank, and, experimentally, mushrooms have been made to bend through nearly a right angle by turning, through this angle, the substratum on which they grow. It must be rare, indeed, for a greater curvature than this to be required in a field or pasture. But the small Coprini, which grow on dung, can be induced to curve through a much greater angle, and the response to gravity is so rapid that the commencement of the curve has been observed within a minute and a half of the change in position of the material on which they grow. In Figure 111 is shown a not quite mature specimen of *Amanita mappa*, which had been pulled up and laid on a flat surface some sixteen hours before the photograph was taken. The bend in the upper part of the stem is well seen in it. But not only does the immature toadstool reäct to gravity by curvature of its stem; the mature fructification also responds by movements of the gills. Figure 109 is a specimen of *Tricholoma rutilans* which was allowed to rest on its edge in an almost vertical position for eighteen hours. Except for one or two above and below, which still remain in a vertical position, *all* the gills have undergone a certain amount of bending, which has tended to turn them back into the vertical plane. Figure 112 is also interesting in this connection. It represents a specimen of *Boletus chrysenteron* which was found growing out from a bank. The brave attempts of the spore tubes to become vertical are well seen in the photograph. Mushrooms have also been shown to reäct to the pressure of surrounding objects by elongation of the stalk. This is clearly an attempt to surmount obstructions, and carry the cap into such a position that it can effectively shed its spores. If the cap of an immature mushroom be surrounded by a ring, so that it cannot expand, the result is considerable elongation of the stem.

The presence or absence of light makes no difference whatever to the development of many fungi. Mushrooms grow equally well in the open fields as in a dark cellar; if lighted on one side only they show not the slightest tendency to turn towards or away from the light. The small Coprini, however, which grow on dung, and therefore among possible obstacles to the free dispersal of their spores, at first bend towards the light, but when clear of obstructions the stem becomes straight again to place the expanding gills in the best position for spore dispersal. Several other forms which grow on trees, and might therefore produce their fructifications within a hollow tree, where they would be of little value for spore-dispersal purposes, are markedly influenced by light. Curious, irregularly branched growths, similar to Figure 113, are produced by *Polyporus squamosus* when growing in the dark. Experimentally these seem to have no tendency to grow toward the light, and will only produce fructifications when exposed to light very early in their development. But in other species e.g., *Lentinus lepideus*, similar curved processes grow *toward* the light, and only when this is reached begin to develop into the spore-bearing fruits normal to the plant. Figure 114 is a curious example of the "Oyster of the Woods" (*Pleurotus ostreatus*). It should be compared with the normal fructification of the same fungus in Figure 115. It was found growing from a deep cleft in a beech tree in Epping Forest. The pale sterile column from the fungus plant, which measured eight inches in length, had been growing out from the interior of the hollow tree towards the light, and not until the light had been reached was a normal fructification developed.

Spore production in most of the larger fungi seems to take place equally by night and by day, and to be independent of light; so long as the fungus is not dried up it is also uninfluenced by the dryness of the atmosphere. Several of the woody forms have been shown to shed their spores at all ordinary temperatures from the freezing-point upwards; spore production takes place in *Lenzites betulina*, for example, at all temperatures between 0° and 30° C. Below freezing-point the formation of spores ceases, but many woody forms will stand freezing for months with reduction of temperature to −17° C., and yet start shedding spores within a few hours of being brought back to ordinary temperatures again.

We have now to consider a special group of fungi, the Coprini, or Ink Fungi, which, like the greater number of toadstools, have their spores distributed by the wind, but which differ from the remainder in many important details. Shaggy Caps (*Coprinus comatus*) is very frequently found growing on decaying refuse of all sorts, and is a very good example of this type. It is to be seen in Figures 110, 117, 118, and 119. Within twenty-four or forty-eight hours of the commencement of spore-dispersal the whole cap has dissolved into an inky fluid, and the stalk has more or less completely collapsed. Before liquefaction begins the fungus (see Figure 117) is cylindrical in form, with the gills pressed tightly together, but prevented from actually touching, except at their free edges, by a layer of thickened tissue in this region. The whole toadstool at this stage is pure white. But a change in colour now occurs, and the lower borders of the gills become pinkish and finally black; at the same time, the lower part of the cap expands a little, so that the toadstool is no longer cylindrical, but cone-shaped. At this stage, shedding of spores begins; but, unlike the other fungi of the mushroom type so far considered, the shedding of spores does not go on all over the gills at once, but the process is confined at first to their lower borders. As soon as these areas have shed their spores, auto-digestion and liquefaction of this region occur, and the fluid thus produced

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either slowly evaporates if the day be fine, or collects in droplets at the outer edge if the air be moist. Meanwhile, however, the area of gill immediately above the liquefied portion is shedding its spores, and as soon as this function is fulfilled it is in turn cleared away, and so the process goes on. While successive areas of the gills are in turn shedding their spores, and then making a clear passage for the fall of other spores, the cap is slowly expanding, so that by the time spore dispersal is almost complete the cap, much reduced in size, is as flat as that of a mushroom or any other similar toadstool. If some of the dark fluid taken from a specimen of Shaggy Caps growing in the field be microscopically examined, it will be found to be practically free from spores. It is, moreover, without appreciable smell, and never seems to be eaten by insects, as was at one time supposed. It is merely the result of the dissolution of a tissue which has served its purpose and is of no further value to the plant. Remembering that the cap remains conical until almost the whole of the spores have been shed, that the stem is much less rigid than in most toadstools of equal size, and that the gills are very closely packed together, it will be seen that, were it not for the removal of useless tissue and the limitation of spore discharge to an area immediately above it, but few of the spores would ever reach the open air. If we look at the light hollow stem and thin flesh of the cap of *Coprinus comatus* it is quite certain that these would be insufficient rigidly to support the gills with their long axes in an exactly horizontal position, as occurs with toadstools of the mushroom type. Nevertheless, for a given weight of tissue used, *Coprinus comatus* is able to shed more spores into the air than is the mushroom. It must therefore be regarded as among the successes of the fungus world, and representing a high order of evolution; nor can we reasonably accept Massee's view that the Coprini are a primitive type from which the other Agarics have developed.

The Puffballs are another group of fungi that have their spores distributed by the wind. When the Giant Puffball (*Calvatia gigantea*, see Figure 75) is mature the upper half of its wall gradually breaks away, exposing a loose tissue which, with the contained spores, is gradually blown about and distributed by the wind. But in most Puffballs, instead of the wall breaking away irregularly, a small opening is formed above, and the wind entering here eddies round inside and carries away the tiny spores with it, or else, blowing across the top, produces a suction action with a like result. I have been much astonished at the quantity of water contained in certain Puffballs. Possibly this may be of value to the plant by raising up the more deeply placed spores which float on it, and thus bringing them nearer to the opening as the season advances. The Star Puffball (*Geaster seriscus*) is a beautiful fungus which differs from the Common Puffball in possessing a double outer coat: this splits into rays, which open out in a star-like manner when the spores are mature. Spore-dispersal takes place at first through the central opening of the inner coat as in other Puffballs, but later on the starry outer coat becomes dry and detached from the substratum, and the whole fungus blows about and the spores are shaken out. Bovista is another puffball with a central opening. It differs from Lycoperdon in the absence of a stalk and in possessing a smooth exterior entirely devoid of warts. When mature the whole fungus becomes detached from the ground and is blown about by the wind, shedding its spores as it goes.

(*To be continued.*)

THE ALCHEMICAL SOCIETY.

THE eleventh general meeting of the Alchemical Society was held at the International Club, Regent Street, S.W., on Friday, March 13th. The chair was occupied by the acting president, Mr. H. Stanley Redgrove, B.Sc., F.C.S., and a very interesting lecture was delivered by Mr. B. Ralph Rowbottom, dealing with the life, thought, and influence of the English alchemist and philosopher, Roger Bacon. After stating that very little was known of the early events in Roger Bacon's life, the lecturer pointed out that two of the factors undoubtedly potent in the formation of his original and pregnant philosophy were his deep knowledge of mathematics, acquired during his stay at Oxford, and his study, at a slightly later period, of the best Arabic writers. The fact was next emphasised that, although Roger Bacon is usually known to us as an alchemist, his great achievement was the creation of a system, to be applied in the unravelling of the laws of nature, which was remarkably similar to that we to-day call scientific method. The lecturer proceeded to deal with several of Roger Bacon's works, pointing out the extremely short time in which the most important were written, and he finally gave the construction of the *Opus Majus* in detail. In conclusion Mr. Rowbottom suggested that the day will probably come when the name of Roger Bacon will no longer call to mind magic or "spooks," but a man who, born into an ignorant age, shed a light not to be considered negligible even in the present century.

The lecture was followed by an animated discussion.

The full text of the lecture and an abstract of the discussion is published in the March number of the *Journal of the Alchemical Society*.

FIGURE 114. An unusual form of *Pleurotus ostreatus*, with long stalk, found growing from the interior of a hollow tree.

FIGURE 115. An ordinary form of *Pleurotus ostreatus* growing from the side of a tree without any stalk.

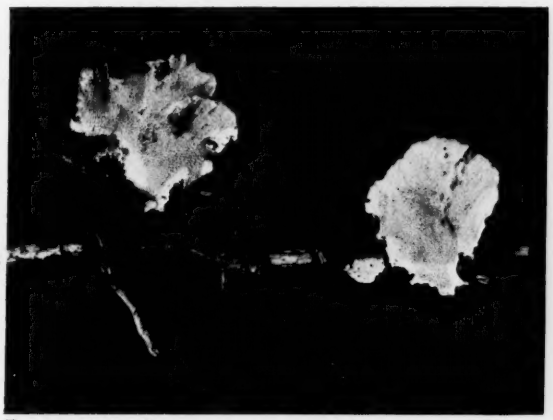

FIGURE 116. *Fomes annosus*, which grows on the roots of conifers.

FIGURE 117. Shaggy-caps.—*Coprinus comatus*, before it has begun to shed its spores.

FIGURE 118. Shaggy-caps.—*Coprinus comatus*, at the stage when its spores are being shed.

FIGURE 119. Shaggy-caps.—*Coprinus comatus*, after shedding its spores.

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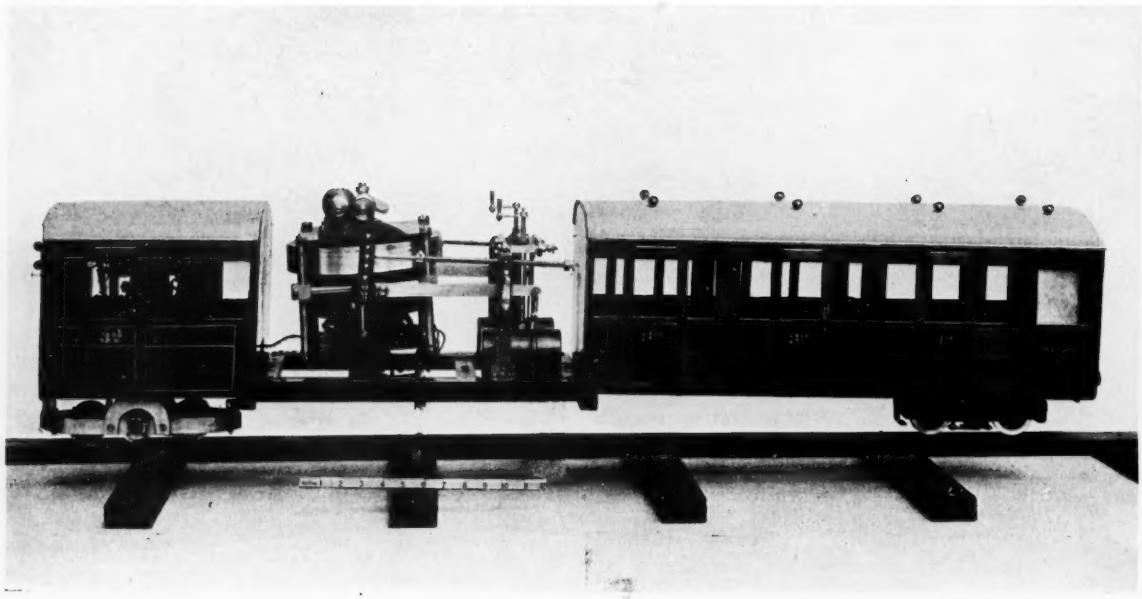

FIGURE 120. M. Schilowsky's Working Model Gyroscope Mono-rail Car.

The Gyroscope is seen freely exposed to view between the two carriages, and is placed, for inspection purposes only, far higher up than it would be in an actual carriage or train. This working model is driven by electric current, which moves the car and also revolves the horizontal gyroscope. In an actual carriage or train the gyroscope portion would be enclosed as in the motor car figured below.

FIGURE 121. M. Schilowsky's Motor Car on his Gyroscope principle.

A motor gyroscope car with the inventor seated beside the driver. The gyroscope is hidden, and is situated in the closed compartment between the driver's seat and the back seat. The two wheels here shown are ordinary tyred road wheels. For running on a rail these two wheels would be replaced by flanged ones for the purpose. The car and gyroscope derive their motive power from petrol.

THE SCHILOWSKY GYROSCOPE MONO-RAIL SYSTEM.

By J. HARRIS STONE, M.A., F.L.S., F.C.S

It came in as a spinning top. We hoped it would develop into a magic ameliorator of many mundane discomforts. Instead of working wonders it has simply shrivelled up, faded away into dusty, shop-soiled insignificance. Yes, it must be admitted that we are rather disappointed with the gyroscope. It has not come up to our expectations. A few years ago it was much to the fore, and everyone was dilating, of course with more or less exaggeration, upon the marvellous advancements which were to follow its adoption. We were to flash through the air on a car poised on a rail, or with lightning speed run up and down mountains suspended from a cable; when we travelled on the sea our vessels were no longer to give rise to sea-sickness, and in many other directions the practical utility of this marvellous piece of mechanism was to be demonstrated. These gyroscope marvels, or some of them, may even yet come to fruition, but just now they are embryonic.

The gyroscope is comparatively quite a modern invention. Its first practical application was in 1744, when Serson invented a spinning top with a polished upper plane surface for giving an artificial horizon at sea, undisturbed by the motion of the ship when the real horizon was obscured by clouds. That instrument was, we know, perfected by Admiral George Ernest Fleuriais, and Gilbert's baragyroscope, an improvement upon it, was devised for showing the Earth's rotation. Of course it has long been known that the gyrostatic principle, in which one degree of freedom is suppressed in the axis, is valuable for imparting steadiness to a moving body, and indeed an attempt to mitigate the rolling of ships with this instrument was made by Schlick. Then for a lengthy period the gyroscope hibernated and was lost sight of.

When Brennan's mono-rail car was exhibited at the Japan-British Exhibition in London a few years ago it caused quite a sensation. Many went specially to see and personally to try this much-talked-of revolution in passenger travel. Those who were fortunate enough to get a ride on the car came away mostly imbued with the idea that the gyroscope was too complicated for practical use. Brennan's invention was so frequently not working, or, as a notice board outside the gates said, "closed for repairs," that the majority of visitors to see the side-show went away without being able to satisfy their curiosity. From that day to this the invention has peacefully slumbered: it seems to have passed from the range of practical utility.

Abroad, particularly in Germany, much more attention has always been and is being devoted to the practical possibilities of the gyroscope than here. The German science museums consequently are far richer in examples of the recent developments of gyroscopic discoveries, inventions, and applications than in this country, but it is satisfactory to note that the authorities of our South Kensington Science Museum are increasing and enlarging the gyroscope department, and I am informed that they have the intention of still further paying increased attention to this important and coming branch of practical science. Better late than never; but it seems a pity that here, as with nearly every other branch of applied science, we seem always to be following suit, and never taking the initiative.

The latest addition to the gyroscope department of the Science Museum is a remarkable working model of a gyroscope mono-rail car which the inventor, M. Peter Schilowsky, has with delightful open-handedness presented to the nation. And here it may be noted that this model is the first model mono-rail car on this principle which has ever been shown to the public with all its working parts freely exposed for public inspection and criticism, so that its location at South Kensington is a distinct feather in the scientific cap of this country. On a curved mono-rail track the car can be seen travelling in either direction, weirdly upright, and quickly righting itself if depressed by external influence. M. Schilowsky, the donor and inventor, is a Russian scientific man, residing temporarily in London. He is quite an enthusiast as to the future possibilities of the gyroscope, and at the same time an idealist. He does not believe in keeping his inventions secret, but, with the true spirit of scientific camaraderie, allows everyone freely to probe and investigate what he has been able to do, trusting that other brains and other imaginations may still further add to and carry on his inventions, so that the day of practical adoption may be hastened. The many problems surrounding the gyroscope are by no means yet solved, but M. Schilowsky has unquestionably overcome some of the obstacles which hitherto have retarded progress. He is distinctly a pioneer in gyroscopic science, and there are only three or four other men similarly engaged, though the attention which will now be directed to M. Schilowsky's models may be the means of adding to the number.

In the first place he avowedly bases his system on that of Brennan. He uses a stabilising force obtained by a high-speed, rapidly revolving, heavy wheel—that is, a gyroscope. He has ingeniously

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utilised its reäctive propensities against pressure for bringing it to its normal position when that normal position has been altered by pressure on the vehicle's lateral or vertical plane. His instrument differs from that of Brennan by being pivoted below the centre of gravity of the gyroscope. As we know, Brennan uses vertically spinning gyroscopes pivoted in the centre of gravity. Schilowsky's gyroscope is pivoted below the centre of gravity, thereby ensuring far greater stability of the vehicle in an upright position, and has specially designed mechanisms formulated on the principle of rachet device engagements for automatically restoring the right (here the horizontal) plane of rotation if it has been disturbed by any cause, such as pressure of the wind, the changing of places by persons inside the car, and so on. This corrective mechanism is automatically controlled by two heavy pendula which are sensitive to the slightest disturbance of the equilibrium of the car and instantly transmit to the gyroscope, through a rachet quadrant, an impulse just of the necessary strength to restore the equilibrium of the car and the right plane of rotation of the gyroscope. M. Schilowsky's system differs also from others in that his gyroscope works without air-tight casing, without lubricating arrangements under pressure, and in several other subsidiary details.

The model car already constructed is worked by electric current, and so is the gyroscope. But in actual practice any other means of obtaining power can be employed to work gyroscope and vehicle. I timed the gyroscope at the Science Museum and found it ran and kept the car upright for over three minutes after the current had been cut off.

The gyroscope in the working model as at present constructed, makes some three thousand revolutions a minute, but in an actual car M. Schilowsky informs me that the maximum number of revolutions will be reduced to from five hundred to eight hundred, for the diameter of the actual gyroscope will be nearly that of the width of the vehicle, and so a great reduction in speed is obtained.

In order that the invention may be fully seen and even minutely inspected in the working model, the gyroscope is placed high up (see Figure 120) on the car and not cased in. In the actual car the gyroscope will be much lower and completely concealed. In the model too (see Figure 120) the gyroscope and its balancing machinery are exposed for the convenience of being inspected. In the actual car of course these machinery details would be enclosed.

M. Schilowsky has also already made an actual motor car (see Figure 121) on his principle, to hold six persons, the gyroscope of which makes one thousand revolutions a minute. This is driven by petrol and the wheels are made to run on a rail or on the ordinary road.

It is simply marvellous, almost uncanny, to notice, as M. Schilowsky's gyroscope revolves, how it automatically readjusts itself to the horizontal plane when by pressure on the frame, or from any other cause, it has been momentarily deflected. One cannot help the thought, on beholding the wonderful precision of the side rachet adjusting machinery, that the machine is imbued with a certain amount of animal intelligence. It is hoped that the inventor—or those who follow in his footsteps—will still further pursue his labours the outcome of which may revolutionise motor traffic on our roads, and make sea travelling devoid of all nauseating experiences. There are also many other directions where the application of gyroscope principles would be useful, especially as a stabilizer for aëroplanes.

The gyroscope is in its infancy, but it is not at all unlikely to grow into a potent power in the world in the near future. The greatest man that ever lived, we should remember, began life as a baby.

RADIOTELEGRAPHIC INVESTIGATION.

The Committee of the British Association which deals with radiotelegraphy is making a special investigation with regard to the effect on the propagation of electric waves of the total eclipse of the Sun, which takes place on August 21st, 1914. On this occasion there will be an exceptional and important opportunity of adding to existing knowledge of the propagation of electric waves through air in sunlight and in darkness, and across the boundaries of illuminated and unilluminated regions. The eclipse will be total along a strip extending from Greenland across Norway, Sweden, Russia, and Persia to the mouth of the Indus. In Russia the duration of totality will be a little more than two minutes.

There are two main points calling for investigation during the eclipse. In the first place the propagation of signal-bearing waves through air in the umbra and penumbra will probably obey laws different as regards absorption and refraction from those obeyed in illuminated air. In the second place the strength, frequency, and character of natural electric waves and of atmospheric discharges may vary.

To investigate the propagation of signals across the umbra it will be necessary to arrange for wireless telegraph stations on either side of the central line of the eclipse to transmit signals at intervals while the umbra passes between them. This transit of the umbra occupies about two minutes. It is thus very desirable that the Scandinavian and Russian stations should transmit frequently throughout several minutes before, during, and after totality.

The investigation of strays is of as great interest as that of signals.

The Committee propose to prepare and circulate special forms for the collection of statistics of both, especially within the hemisphere likely to be affected by the eclipse; they will endeavour to make provision for the transmission of special signals at times to be indicated on the forms; and they will offer for the consideration of the authorities controlling stations near the central line a simple programme of work. Digests of the statistics, together with the conclusions drawn from the analysis, will be published in due course.

The Committee would be greatly aided in the organisation of this investigation if those possessing the necessary facilities, and willing to make observations during the eclipse, would communicate with the Honorary Secretary, Dr. W. Eccles, University College, London, W.C., at the earliest possible date.

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CORRESPONDENCE.

HIGH TIDE AT FREEMANTLE.

To the Editors of " KNOWLEDGE."

SIRS,—In the literature at my immediate disposal I cannot find any specific reference to the state of tides at Freemantle or in West Australia. There are, however, certain major disturbing influences which may in certain conditions produce important effects on the regularity of the tides. The Moon is not in general on the plane of the Equator, and hence there is a difference between its zenith and nadir distances. Consequently there is a difference in the tides corresponding to these positions of the Moon. This gives a diurnal irregularity or a "diurnal tide," which may interfere very considerably with the normal semi-diurnal. On the British coasts the diurnal tide is not noticeable, but in some places it may be as large as the semi-diurnal, or nearly so. On the coast of Queensland the diurnal irregularity is important, with the result that elaborate tide-prediction tables have been prepared for these seas. At Aden the tides are again complicated in this way, and twice a month one high water is obliterated. It is to be noticed that twice in the month the Moon crosses the celestial Equator, and the diurnal tide fails. Again, in estuaries, currents run up channel after the flow has ceased, and places some way from the sea have high water (and similarly low water) later than those on the coast. At such places there may be two or three rises and falls for one at the coast; thus there are two at Southampton. The times of rising and falling, too, may be considerably different, as in the Severn Estuary.

For a general treatise on the tides your correspondent may be referred to Sir G. H. Darwin's book on the Tides, and to his Bakerian Lecture on the subject (*Phil. Trans. Roy. Soc.*, A, 1891). The British Association Report for 1885 and the Admiralty Manuals (1886 *et seq.*) also supply information. These discussions are, of course, largely highly mathematical; but one knowing the local conditions, and possessed of the necessary mathematical equipment, could use them to gain accurate knowledge of the local effects of tidal influences.

A. STEVENS.

GEOGRAPHICAL DEPARTMENT,
UNIVERSITY OF GLASGOW.

DIARY OF A WASPS' NEST.

Early in the spring of 1913 I made several holes in the garden here, thinking that possibly a queen wasp might adopt the locality as a suitable spot in which to rear her brood. The idea was realised and I took a few notes:—

May 15.—Queen wasp took possession.

June 15.—The queen had made about eight hundred journeys to and from nest to this date when young wasps were first observed.

" 16.—Queen flew from and to nest as usual in morning. At midday she crawled out of hole and seemed numbed and helpless. Picked her up and put her in the sun, but she could not nearly fly. Number of wasps flying to and from the nest per hour 16.

" 18.—Queen came out of hole at 7.30 a.m., fanning with her wings and looking quite lively. Flew away at 8 a.m. and returned at 10.30 a.m. During her absence the young wasps remained at home.

" 19.—Queen emerged fluttering her wings and moving briskly, as if intending to fly; but after remaining on brink of hole for half an hour she withdrew. So far as observed she never came out again.

July 6.—Number flying to and fro 136.
" 15.— " " " 240.
" 23.— " " " 397.
" 26.— " " " 855.
" 30.— " " " 1134.

Aug. 3.—Heavy thunderstorm. Rain water got into the nest and damaged it. The number of wasps seen declined after this date.

" 15.—Number flying to and fro 744 per hour.

" 20.—Young queens seen crawling about at mouth of hole.

" 25.—About 40 queens flew away.

" 28.—Hot day. 120 queens flew away.

" 29.—Mostly cloudy. 95 " " "

" 30.—Hot and fine. 165 " " "

" 31.—Cloudy, cool. 40 " " "

Sept. 1.—Cloudy, rain. 20 " " "

" 2.—Cloudy, cool. 20 " " "

" 3.—Fine and warm morning. 225 queens flew away.

Sept. 4.—Cloudy and wet. No queens seen.

" 5.—A few languid queens flew off.

" 6.— " " " "

Altogether about 740 queens flew away.

" 11.—The nest showing little signs of activity, I dug it out and found the rain had ruined it. Many dead wasps and queens. There were six terraces of cells, the largest pair being 6½ inches diameter. The whole included 4,800 individual cells.

In the spring of 1913 I think there was an unusual number of queen wasps about, due perhaps to the mildness of the preceding winter. This is a pretty populous neighbourhood, but I must have seen one hundred and fifty queens searching for domiciles in my garden during the months April, May, and June. They were chiefly observed in May; the last one noted was on June 9.

I used to sit near the nest and watch the interesting antics of the insects. The number of flies of different kinds they brought home was astonishing. The outgoing wasps carried away little lumps of earth to make room for additional cell accommodation. In June the wasps' working day was a long one, for they began soon after 3 a.m. and ended just before 9 p.m., so they were active during nearly eighteen hours.

But these facts are probably well known, and were indeed familiar to me more than fifty years ago when as a boy I cultivated wasps.

By careful observation close to the entrance I concluded that in July and August the daily number of flies brought home to the nest must have been three thousand or four thousand. Now flies in many respects are not regarded as agreeable additions to our domestic economy and comfort, so that if my wasps' nest provided the neighbourhood with one noxious insect it practically rid it of another.

My nest of 1913 was comparatively small. In my younger days I have taken them when containing from fifteen thousand to twenty thousand cells.

W. F. DENNING.

EGERTON ROAD,
BRISTOL.

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THE FACE OF THE SKY FOR MAY.

By A. C. D. CROMMELIN, B.A., D.Sc., F.R.A.S.

TABLE 18.

Date.	Sun. R.A.	Sun. Dec.	Moon. R.A.	Moon. Dec.	Mercury. R.A.	Mercury. Dec.	Venus. R.A.	Venus. Dec.	Mars. R.A.	Mars. Dec.	Jupiter. R.A.	Jupiter. Dec.	Uranus. R.A.	Uranus. Dec.	Neptune. R.A.	Neptune. Dec.
Greenwich Noon.	h. m.	°	h. m.	°	h. m.	°	h. m.	°	h. m	°	h. m.	°	h. m.	°	h. m.	°
May 3	2 39·0	N.15·5	9 13·2	N.18·6	1 43·4	N. 8·7	4 0·7	N.21·0	8 13·9	N.21·8	21 30·4	S.15·4	20 56·7	S. 17·9	7 50·1	N.20·6
,, 8	2 58·3	16·9	13 36·0	S. 13·8	2 19·4	12·6	4 26·4	22·3	8 24·3	21·2	21 32·6	15·3	20 56·9	17·9	7 50·4	20·6
,, 13	3 17·8	18·2	18 48·3	S. 27·4	2 59·2	16·5	4 52·5	23·4	8 34·8	20·5	21 34·4	15·1	20 57·0	17·9	7 50·8	20·6
,, 18	3 37·5	19·4	23 1·6	S. 6·0	3 42·5	20·1	5 18·9	24·1	8 45·5	19·8	21 36·0	15·0	20 57·1	17·9	7 51·3	20·6
,, 23	3 57·5	20·5	2 38·6	N.20·1	4 27·8	23·0	5 45·4	24·6	8 56·2	19·0	21 37·4	14·9	20 57·0	17·9	7 51·8	20·6
,, 28	4 17·7	N.21·4	7 10·3	N.26·6	5 12·5	N.24·8	6 12·1	N.24·8	9 7·1	N.18·1	21 38·4	S.14·9	20 56·8	S. 17·9	7 52·3	N.20·5

TABLE 19.

Date.	Sun. P	Sun. B	Sun. L	Moon. P	Mars. P	Mars. B	Mars. L	Mars. T	Jupiter. P	Jupiter. B	Jupiter. L_1	Jupiter. L_2	Jupiter. T_1	Jupiter. T_2
Greenwich Noon.	°	°	°	°	°	°	°	h. m.	°	°	°	°	h. m.	h. m.
May 3	−24·0	−3·9	60·5	+15·9	− 8·3	+12·7	137·1	2 37 *m*	−20·5	0·0	5·1	36·6	2 0 *m*	8 54 *e*
,, 8	22·9	3·4	354·4	+20·3	6·8	13·6	89·1	5 54 *m*	20·6	+0·1	74·4	67·8	0 6 *m*	0 11 *m*
,, 13	21·7	2·8	288·3	− 4·1	5·3	14·6	41·0	9 11 *m*	20·8	0·1	143·8	99·1	8 3 *m*	7 11 *e*
,, 18	20·4	2·2	222·1	−21·1	3·7	15·5	352·9	0 29 *e*	20·9	0·1	213·3	130·5	6 9 *m*	8 23 *m*
,, 23	18·8	1·6	156·0	−17·2	2·1	16·4	304·6	3 48 *e*	21·0	0·2	282·9	161·9	11 56 *e*	5 27 *e*
,, 28	−17·1	−1·0	89·8	+ 6·1	− 0·5	+17·3	256·4	7 6 *e*	−21·0	+0·2	352·5	193·4	2 21 *m*	4 35 *e*

P is the position angle of the North end of the body's axis measured eastward from the North Point of the disc. B, L are the helio-(planeto-)graphical latitude and longitude of the centre of the disc. In the case of Mars, T is the time of passage of Fastigium Aryn across the centre of the disc. In the case of Jupiter, System I refers to the rapidly rotating equatorial zone, System II to the temperate zones, which rotate more slowly. To find intermediate passages of the zero meridian of either system across the centre of the disc, apply to T_1, T_2 multiples of $9^h\ 50^m{\cdot}5$, $9^h\ 55^m{\cdot}7$ respectively.

The letters *m*, *e*, stand for morning, evening. The day is taken as beginning at midnight.

THE SUN continues its Northward march but with slackening speed. Its semi-diameter diminishes from 15′ 54″ to 15′ 48″. Sunrise changes from $4^h\ 38^m$ to $3^h\ 53^m$; sunset from $7^h\ 18^m$ to $8^h\ 3^m$. There is no real night at the end of May.

MERCURY is a morning star till 17th, when it is in superior conjunction, and is occulted by the Sun. Semi-diameter 3″. Illumination increases from $\frac{3}{4}$ to Full, and then diminishes to $\frac{1}{8}$.

VENUS is an evening star, $\frac{9}{10}$ of disc illuminated. Semi-diameter 5½″. 2° 10′ North of Saturn on 16th.

THE MOON.—First Quarter $3^d\ 6^h\ 29^m$ *m*; Full $9^d\ 9^h\ 31^m$ *e*. Last Quarter $16^d\ 10^h\ 12^m$ *e*. New $25^d\ 2^h\ 35^m$ *m*. Perigee $8^d\ 8^h$ *e*. Apogee $21^d\ 4^h$ *m*, semi-diameter 16′ 40″, 14′ 45″ respectively. Maximum Librations, 2° 7° E, 11^d 7° N, 14^d 7° W, 25^d 7° S, 29^d 6° E. The letters indicate the region of the Moon's limb brought into view by libration. E., W. are with reference to our sky, not as they would appear to an observer on the Moon. (See Table 21.)

MARS is advancing through Cancer. 20′ North of η on 9th, in Praesepe on 13th, 1° 38′ South of γ on 15th. Occulted by Moon on 30th, 5^h *e*. The semi-diameter during April diminishes from 3″ to 2½″. The unilluminated lune is on the East: its width diminishes from $\frac{6}{10}$″ to ½″.

JUPITER is a morning star. Polar semi-diameter, 18″.

Configuration of satellites at 3^h *m* for an inverting telescope.

TABLE 20.

Day.	West.	East.	Day.	West.	East.
May 1	1 ○	$\frac{2}{3}$4	May 17	21 ○	34
,, 2	○	$\frac{2}{3}$43	,, 18	2 ○	314
,, 3	21 ○	43	,, 19	3 ○	24 1●
,, 4	4 ⊙	2●	,, 20	3 ⊙	4
,, 5	43 ○	12	,, 21	432 ○	1
,, 6	43$\frac{1}{2}$ ○		,, 22	41 ○	32
,, 7	423 ○	1	,, 23	4 ○	123
,, 8	41 ○	$\frac{2}{3}$4	,, 24	4$\frac{1}{2}$ ○	3
,, 9	4 ○	213	,, 25	42 ○	13
,, 10	421 ○	3	,, 26	431 ○	2
,, 11	4 ○	31 2●	,, 27	34 ⊙	2
,, 12	3 ○	42 1●	,, 28	32 ○	1 4●
,, 13	321 ○	4	,, 29	1 ○	24 3●
,, 14	23 ○	14	,, 30		1234
,, 15	○	324	,, 31	12 ○	34
,, 16	○	1234			

The following satellite phenomena are visible at Greenwich all in the morning hours, $3^d\ 4^h\ 11^m\ 13^s$ I. Ec. D.; $4^d\ 2^h\ 47^m\ 49^s$ I. Tr. I.; $3^h\ 44^m\ 57^s$ I. Sh. E.; $4^h\ 12^m\ 11^s$ III. Tr. E.; $5^d\ 2^h\ 19^m\ 53^s$ I. Oc. R.; $11^d\ 1^h\ 58^m\ 59^s$ II. Ec. D.; $2^h\ 46^m\ 56^s$ III. Sh. E.; $3^h\ 22^m\ 58^s$ I. Sh. I.; $12^d\ 4^h\ 14^m\ 33^s$ I. Oc. R.; $13^d\ 2^h\ 9^m\ 35^s$ II. Tr. E.; $18^d\ 3^h\ 10^m\ 25^s$ III. Sh. I.; $19^d\ 2^h\ 27^m\ 36^s$ I. Ec. D.; $20^d\ 1^h\ 50^m\ 32^s$ II. Tr. I.; $1^h\ 59^m\ 58^s$ I. Sh. E.; $2^h\ 2^m\ 0^s$ II. Sh. E.; $3^h\ 18^m\ 44^s$ I. Tr. E.;

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$22^d\ 2^h\ 20^m\ 6^s$ III. Oc. R.; $27^d\ 1^h\ 44^m\ 10^s$ II. Sh. I.; $2^h\ 55^m\ 10^s$ I. Tr. I.; $3^h\ 53^m\ 22^s$ I. Sh. E.; $28^d\ 2^h\ 28^m\ 57^s$ I. Oc. R.: $29^d\ 0^h\ 53^m\ 50^s$ III. Ec. R.; $1^h\ 49^m\ 6^s$ II. Oc. R.; $2^h\ 33^m\ 7^s$ III. Oc. D. Attention is called to the simultaneous presence of two satellites on the disc on the 4th and 20th.

The eclipses will take place to the left of the disc in an inverting telescope, taking the direction of the belts as horizontal.

SATURN is too near the Sun for convenient observation. 2° 10′ South of Venus on the 16th.

URANUS is a morning star, but badly placed.

NEPTUNE is an evening star in Cancer, semi-diameter 1″.

DOUBLE STARS AND CLUSTERS.—The tables of these given two years ago are again available, and readers are referred to the corresponding month of two years ago.

VARIABLE STARS.—The list will be restricted to two hours of Right Ascension each month. The stars given in recent months continue to be observable. (See Table 22.)

METEOR SHOWERS (from Mr. Denning's List):—

Date.	Radiant. R.A.	Radiant. Dec.	Remarks.
	°	°	
Mar.-May ...	263	+ 62	Rather swift.
Apl.-May ...	193	+ 58	Slow, yellow.
Apl.-May ...	296	+ 0	Swift, streaks.
May 1-6 ...	338	− 2	Aquarids swift, streaks.
,, 7 ...	246	+ 3	Slow, bright.
,, 11-18 ...	231	+ 27	Slow, small.
,, 30-Aug.	333	+ 28	Swift, streaks.
May-June ...	280	+ 32	Swift.
May-July ...	252	− 21	Slow, trains.
May 18-31 ...	245	+ 29	Swift, white.

In the cases where the radiant is stated to be active for several months, there is a difference of opinion as to whether it can be regarded as a single shower, or a combination of several.

TABLE 21. Occultations of stars by the Moon visible at Greenwich.

Date.	Star's Name.	Magnitude.	Disappearance. Time.	Disappearance. Angle from N. to E.	Reappearance. Time.	Reappearance. Angle from N. to E.
1914.			h. m.	°	h. m.	°
May 2 ...	BD+24°·1806	7·0	0 31 *m*	130	—	—
,, 4 ...	45 Leonis	5·8	7 55 *e*	140	9 3 *e*	292
,, 5 ...	49 Leonis	5·7	0 14 *m*	111	1 9 *m*	309
,, 6 ...	Wash. 789	6·9	7 39 *e*	116	—	—
,, 8 ...	BD−11°·3469	7·0	1 48 *m*	92	—	—
,, 10 ...	Lacaille 6719	6·9	—	—	10 47 *e*	305
,, 10 ..	Stone 8802	7·0	—	—	11 31 *e*	289
,, 12 ...	Wash. 1120	6·8	—	—	0 36 *m*	192
,, 14 ...	BAC 6666	5·7	1 15 *m*	96	2 29 *m*	242
,, 17 ...	ι Aquarii	4·4	1 53 *m*	41	2 58 *m*	268
,, 19 ...	Wash. 1574	7·0	—	—	2 28 *m*	234
,, 28 ...	BAC 2506	6·3	10 25 *e*	143	11 4 *e*	249
,, 28 ...	BAC 2514	6·0	10 57 *e*	166	11 20 *e*	225
,, 30 ...	Mars	—	5 6 *e*	145	6 16 *e*	278
,, 31 ...	Regulus	1·3	4 50 *e*	127	6 3 *e*	302

From New to Full disappearances occur at the Dark Limb, from Full to New reappearances.

Attention is called to the occultations of Mars and Regulus; both occur in daylight, but at a considerable altitude. They should be readily observable if the sky be clear.

TABLE 22. NON-ALGOL STARS.

Star.	Right Ascension.	Declination.	Magnitudes.	Period.	Date of Maximum.
	h. m.	°		d.	
U Urs. Min.	14 16	+67 ·2	7·6 to 12·0	327	April 21.
S Boötis	14 20	+54 ·2	7·7 to 13·0	273	April 8.
V Boötis	14 26	+39 ·2	6·4 to 11·3	258·5	May 8.
R V Boötis	14 36	+32 ·9	7·6 to 8·6	200	Feb. 4, August 23.
R W Boötis	14 38	+31 ·9	7·3 to 7·7	unknown	
R Y Boötis	14 46	+23 ·4	7·1 to 7·4	9	Cepheid.
δ Librae	14 57	− 8 ·2	5·0 to 5·9	2·32735	Algol Star.
U Coronae	15 15	+32 ·0	7·9 to 9·1	3·452211	Algol Star.
R Serpentis	15 47	+15 ·4	5·8 to 13·0	357·2	May 10.

Minimum of δ Librae May $2^d\ 0^h{\cdot}9$ *e*. Others may be found from period.
Minimum of U Coronae $2^d\ 9^h{\cdot}8$ *e*. ,, ,, ,, ,,
Principal Minima of β Lyrae May $8^d\ 2^h$ *e*, 21^d Noon. Period $12^d\ 21^h{\cdot}8$.

XUM

A BRITISH FOLK MUSEUM.

By W. RUSKIN BUTTERFIELD.

(Illustrated from photographs by the writer and others.)

IN the issue of "KNOWLEDGE" for August last an outline was given of a scheme for the utilisation of the Crystal Palace and grounds for a British Folk-Museum. Doubts have, however, been expressed, both in comments on the scheme in the daily Press and in private letters to myself, whether, in view of the sweeping changes that have taken place in these islands, and especially in England, the proposal has not come too late in the day for effective fulfilment. Happily, I believe such doubts to be unfounded.

Notwithstanding the wanton treatment to which our ancient buildings have been uncomplainingly subjected, there still survive numerous examples which will bear comparison, alike as regards antiquity and intrinsic merit, with anything to be found in the Continental Folk-Museums. In Sussex and Kent—the counties with which I am most familiar—I have been not a little surprised to find how many timber cottages and farmhouses belonging to the close of the mediaeval period still exist. These homely and picturesque dwellings, unlike the great houses of the land, owe little or nothing to foreign influence: they were constructed by native workmen from material provided by nature at hand and with loyal obedience to the traditional methods of the district; and herein lies this special value, for they portray the culture-status of the folk of the time, and not merely of their builders. They possess well-marked characteristics by which they may be readily distinguished, and as they throw light upon the home-life of the people at a time when social habits were very different from those of the present, a brief description may be attempted. Their external appearance is well illustrated by the Old Paper Mill, near Sandhurst, Kent (see Figure 127).

The ground plan of these houses is a simple rectangle. The roof is plain with a high-pitched central ridge, and the ends are usually hipped. A striking feature is their bilaterally symmetrical form; in other words, a line drawn vertically down the middle of the front wall divides them into two corresponding halves, and this is the case also if a line be drawn down the middle of an end wall. As a rule the upper story at each end overhangs in front, at the side, and at the back, thus giving a greater floor area to the rooms above. The original windows were mere unglazed openings in the walls, divided by two or more upright mullions of wood, square in section, and inserted with one of the angles to the front. The openings could be closed on the inside by means of sliding shutters. It will be seen that, besides the main posts, the battens in the walls are all upright, and they are set fairly closely together, the interspaces of lath and plaster being of about the same width as the battens themselves. This close and upright timbering is very characteristic of early work.

Originally the rooms were normally five in number and were disposed as follows: In the middle was the hall, which was open from floor to roof, and extended from the front wall to that at the back, the length coinciding with the recessed portion seen in the Old Paper Mill. At each end were two rooms in two stories. The upper room at the higher end of the house (that is to say, the end remote from the doorway, which never occupied a central position, but was always nearer one side of the hall than the other) was the solar or withdrawing room, and was reserved for the use of the family. Below the solar was a chamber, either whole or divided by a middle partition, running parallel with the front wall. The lower room at the opposite end (often divided in like manner by a middle partition) constituted the buttery and pantry, while above were the sleeping quarters of the domestics. The hall formed a common room for the family and dependents, and here meals were partaken of. Beyond a long table with its attendant forms for seats, and perhaps two or three chairs, it contained little furniture. The walls were mostly devoid of ornament, but their plainness was sometimes relieved by simple patterns "combed" in the plaster. At the upper end of the hall, however, was usually a panelled screen which gave distinction to the apartment. The chambers contained little beyond beds, chests, and chairs or stools. The fire was placed at the lower end of the hall, and as there was no chimney the smoke made its exit as best it could between the tiles or thatch or at the window openings or doors.

This, then, is a type of dwelling as distinctly national as anything can be, and at least one good example should be rescued and preserved in a national Folk-Museum before the opportunity shall have gone beyond recall.

The farmhouse near Ticehurst, Sussex (see Figure 130), differs from the one just described in being flat-fronted, though the ends are overhung; while in Stream Farm, Sedlescombe, Sussex (see Figure 128), is seen an innovation in the form of a gable at the upper or solar end. As the sixteenth century wore on a decided change took place in the social habits of the people, and the change is reflected in a departure from the time-honoured type of house. A need for greater privacy in the sleeping

FIGURE 122.
An 18th-century Staybusk.

FIGURE 123.
Carved Nutcrackers.

FIGURE 124.
Carved Nutcrackers.

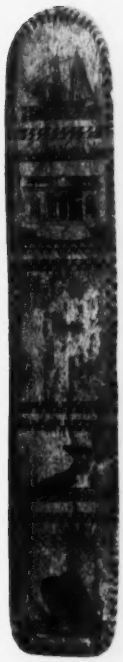


FIGURE 125.
An 18th-century Staybusk.

From a photograph *by H. J. Jarman.*

FIGURE 126. The Guildhall, Lavenham.

FIGURE 127. The Old Paper Mill, Sandhurst, Kent.

FIGURE 128. Stream Farm, Sedlescombe, near Hastings, a 16th-century timber house.

FIGURE 129. A 16th-century House at Westham, Pevensey.

FIGURE 130. Wardsbrook Farm, Ticehurst, Sussex.

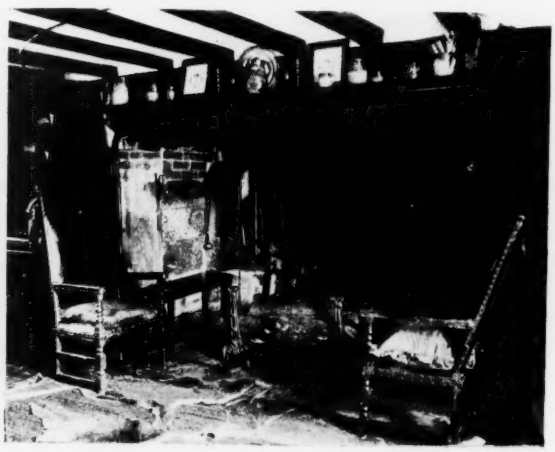


FIGURE 131. Fireplace in the Mill House, Wadhurst, Sussex.

FIGURE 132. The "Mermaid," Rye, Sussex.

(Figures 127 and 128 from photographs by Edward P. Overton.)

apartments began to be felt, which was met by constructing a room above the hall. The Westham house (see Figure 129) is a case in point. It will be observed that it overhangs along the whole front. Here is a second type of house that should be represented in a national Folk-Museum. About the same time chimneys began to come into general use with large recessed hearths. The great open hearth, or "down" hearth, to give it its local name, marks a decided advance in home comfort, and it became the family shrine, especially in winter, when the whole household would seat themselves within or in front of its capacious and hospitable opening. A series of fireplaces, showing the gradual changes that have taken place in the character of the hearth and of its many appliances, would form an attractive feature in a national Folk-Museum. The illustration of the "down" hearth at the Mill House, near Wadhurst (see Figure 131), will show how picturesque is an old Sussex fireplace, with its ornamental fireback, its "dogs," chimney-crane, pothooks, trivets, and other objects.

During the seventeenth century other changes are observable in the smaller timber houses. Gables and dormer-windows are commonly introduced, and the close, upright timbering gives place to panels, often containing curved braces, while the main timbers, constituting the framework, are no longer enriched with mouldings. The interiors are more subdivided, and the rooms are consequently small and mean. Houses of this kind exist in plenty throughout Sussex and Kent.

It may safely be asserted that other English counties are not less rich in old domestic buildings. Suffolk is justly famous in this respect, and in the Guildhall at Lavenham (see Figure 126) it possesses a beautiful example of fifteenth-century English workmanship at its best. No one would wish to remove such a delightful building from its ancient site, even to grace a national Folk-Museum, but a faithful copy could be made of it. Essex likewise has a fine fifteenth-century timber house of small size in Paycocke's, Coggeshall. This, too, is well worth copying, although unlike the Lavenham Guildhall, which is a purely native product, Paycocke's exhibits pronounced foreign influence. Cheshire, Herefordshire, Worcestershire, Hertfordshire, and other counties also afford ample evidence that, in spite of the hasty and unconsidered clearances of former times, many small timber houses have escaped.

Thus, without considering the remaining parts of the British Islands, it is clear that there is no lack of suitable material, so far as domestic houses are concerned, for a comprehensive national Folk-Museum. But these houses are gradually disappearing, and unless a State refuge is provided to which the best of them can be removed when they are threatened with demolition there is very grave danger that they may be lost to posterity. As was explained in the former article, the houses on their reërection in the grounds of the national Folk-Museum would be restored to their original form, all subsequent alterations and additions being omitted, and they would be provided with the furniture and appliances appropriate to their period, size, and locality.

Leaving the subject of buildings, it must be admitted that in one category of objects there is a regrettable paucity—namely, objects displaying folk-art, such as the stay-busks and nutcrackers illustrated in Figures 122–125. One reason for this is that folk-art never seems to have flourished so extensively in this country as, for instance, in Sweden, Russia, and Switzerland; and another reason is that folk-art has languished from neglect. As Mr. Cecil Sharp truly observes: "We are apt, as civilisation advances, to imagine that art is the province of the rich and cultured; that only people who are very highly educated can appreciate art, and so forth. This is, of course, the reverse of the facts of history; because there is no art in the world that ever came into civilisation in the top story. All arts began at the bottom: they all came from people who could neither read nor write; they were all created, in the first instance, by the folk; and really the only fear of art becoming artificial or valueless is that it should be divorced from the folk from whom it sprang in the first instance." Before the days of complicated machinery and of extreme division of labour, workmen often fashioned the articles upon which they were employed from the first stage to the last, from the raw material to the completed product; and while the work grew under their hands they would elaborate it with ornament, drawing upon the traditional sources for their inspiration. Especially valuable are those objects made by men and women during intervals of leisure as presents or for use during some festival, as they are the highest expression of folk-culture. When a man carved a stay-busk for his sweetheart, or a maid embroidered a smock-frock for her bridegroom, the utmost skill at command was evoked and the utmost efforts were put forth. But it is precisely such things as these that the museums have hitherto neglected or at most treated with scant regard. The eyes of curators have been fixed in the ends of the earth, and the objects illustrating the culture-history of our own people have for the most part been overlooked.

A national Folk-Museum would concern itself exclusively, and as exhaustively as possible, with the peoples of the British Islands. It would trace the development of indigenous culture and characteristics; it would illustrate the home life, the occupations, the amusements, the inventions, the distinctive beliefs, the manners and customs, of the people of all grades and from the remotest times. It would hold up a faithful mirror to our whole past.

XUM

STELLAR SPECTROSCOPY FOR BEGINNERS. VI.

By PROFESSOR A. W. BICKERTON, A.R.S.M.

Reversal of the Lines of the Spectrum.

A spirit lamp in which soda is burning glows with a beautiful yellow light. If this flame is looked at through a prism fixed in a card, instead of the rainbow-tinted spectrum that would have been seen had the source been the limelight, we see the yellow flame displaced, yet looking exactly as it did without the prism. This is because, although the prism bends a pure tint, it does not separate it, as it has only one constituent.

If the limelight be placed behind this flame, the flame appears through the prism as a dark form on a brightly coloured background. This phenomenon is called isochromatic reversal; the cause of it is called sympathy of vibration. This sympathy, when clearly understood, is a principle of great importance in the comprehension of many phenomena, such, for instance, as wireless telegraphy, and beauty of tone in singing and instrumental music. It is also needed in understanding articulate language, and amongst many other things it is especially valuable in stellar spectroscopy.

There is at present a vicious tendency to apply science without comprehending its principles. Thus, without the student knowing basic chemistry, we teach its application to, say, gas manufacture, to soap making, to fluxes, to digestion, to dyeing cloth, and many special arts. Yet all very successful teachers will tell you that in order to apply science thoroughly to any art the quickest way to full success is to teach its basic principles.

This attempt to detach the art from the science has been the bane of the immediate past: it was nothing like so prevalent in the time of Faraday, Darwin, Huxley, Tindall, and Frankland. I was glad to see at their great conference a strong revolt on the part of science masters against this most vicious practice. The London County Council, who are now having five hundred non-vocational lectures given, are on the same right track; but it is a hard road. I have found that students tend to resent basic teaching intensely; they fancy they are not being taken the shortest cut. Really, of course, these first principles should be taught in the primary schools. When clearly explained and simply illustrated, children absolutely love basic science. To be successful, under good examiners, basic teaching is essential, and it is the same for one's own personal comprehension. So let us, as a striking instance, try and understand sympathy of vibration on which this principle of reversal and so much else depends.

Sympathy of Vibration.

Look at a child swinging another: it gives a slight push, then carefully timing the second impulse the swinging child moves further. When a score or so of well-timed pushes had been given, the latter goes high into the air. So an elder child on a swing gives a movement of its legs, keeps timing these movements, and presently carries itself so high that the ropes are momentarily horizontal in the air.

If we have two tuning-forks of exactly the same pitch, each on a good resonating box, on making one sound loudly, and then stopping it suddenly, the other will be found to have taken up the note. The first fork gave impulses to the air, the air pushed the other fork and kept pushing it exactly in time, and so its vibrations grew larger and larger. Stick a piece of paper on the prongs of the second fork and it moves more slowly and is out of time, and there is no sympathy. Resonance is another example of the same kind. Take a singer's tuning-fork, vibrate it, and hold it over a tumbler; there is no reinforcement of the sound. Partly cover the tumbler with the hand and hold the fork in the contracting space; presently at a certain-sized opening, when the time of the periods of the vibrating air corresponds with those of the fork, the tone bursts forth loudly.

Like the isochronic tuning-forks, all atoms of sodium have the same note; if some are vibrating they make the other atoms of sodium vibrate also; but they do not act on atoms of other elements. An atom picks up its own rate of vibration out of white light, because such light is of all lengths and one or several of these lengths corresponds with the rates of the atom's vibration. We have seen how a prism alters the position of a sodium flame without altering its appearance; also when a limelight is placed behind the flame, it appears dark.

In Figure 133 a limelight is shining through a sodium flame. The light is somewhat diffused by passing it through slightly ground glass. Some of the rays from the limelight go through the flame. The isochromatic vibrations affect the sodium atoms, and these vibrations are taken out of the white light. The atoms in the flame send off these vibrations in all directions, backward as well as forward; so the rays of the limelight falling on the prism are largely robbed of that particular wave-length. The light from the flame is still there, but the limelight is so much brighter

than the soda flame that the flame seems dark by comparison (see Figure 134). If we use a good spectroscope with a very narrow slit instead of a naked prism, we find that the yellow light is made up of two tints, and a pair of bright lines are seen. These lines also become dark when in front of the limelight.

THE FRAUNHOFER LINES.

We have simply to apply these principles to the Sun, and we easily understand the black lines seen in its spectrum. The outer surface or limit of statical equilibrium of the mixed gaseous sphere, the limit we call the photosphere, is intensely hot. Outside of this surface is a layer of mixed vapours that is dynamically supported by the volcanic action occurring all over the solar surface. This layer is some six hundred miles thick, and is cooler than the photosphere. It is called the reversing layer, because it is gases in this layer that are chiefly concerned in giving the black lines in the solar spectrum. Outside of this layer is another, less dense still. This very rare ensphering shell is supported by molecular velocity: it consists largely of hydrogen, which gives it a red tint; hence it is called the chromosphere. This ensphering shell or layer is some thousands of miles through. We see the lines of these elements bright in integrated flash spectra (see Figure 523, "KNOWLEDGE," December, 1913), and as bright circles or segments of circles in Worthington's differential spectrum (see Figures 521 and 522 on the same page). A somewhat full account of the probable constitution of the solar layers was given in "KNOWLEDGE," February, 1912, pages 52 and 53.

COINCIDENCE OF BRIGHT AND STELLAR REVERSED SPECTRA.

Figure 139 shows the carbon spectrum as seen glowing in the electric arc and that seen in the spectrograms of fourth-type stars: it is a very beautiful example of reversal. It would be difficult to imagine anything more striking than these wonderful series of coincidences of luminosity and shading that Professor Hale has so clearly contrasted in this exquisite photograph.

We have now to apply the double effect of reversal and Doppler's principle in order to try to understand what are called winged lines; afterwards to the broad black bands of Sirian stars, then to the displaced lines and bands of novae, and to the mixed lines to be found in variables and Wolf-Rayet stars.

WINGED LINES.

Before an electric spark is produced, the potential rises and attracts gaseous particles. There appears to be a kind of elastic atmosphere that extends to some distance from the nucleus of the atom. This atomic extension probably causes gaseous adhesion and a number of other phenomena. This atmosphere appears to be a non-conductor of electricity.

As the potential rises the electricity acts inductively and attracts the atoms or molecules more strongly. Presently in their excursions, when the potential is high enough, some of the atoms are so strongly attracted, and hit so hard, that they come close enough to carry off electricity. A strong repulsion follows, and the molecules fly away; as they return they hit harder, and consequently nearly all the electricity is taken away and the potential falls almost to zero. Generally it soon rises again and another spark follows. As the excursions of the atoms are in all directions Doppler's principle comes in; and as the light falls on the slit of the spectroscope the lines broaden. Suppose we interpose a lens, and the image of the poles and spark be formed on the slit of a differential spectroscope, we get a detailed spectrum. If we take a "long line," that is, an overtone that does not die down quickly, it carries its vibrations from pole to pole, but the very high speed of the atom in space only reaches a short distance from the poles. Hence the lines are only wide near the poles, so with a narrow slit the lines appear as in Figure 61 (see "KNOWLEDGE," March, 1914). But the outer atoms are cooler than those near the pole, and the light rays shine through the outer layers and sometimes suffer reversal; and because the outer atoms move slowly we have a dark dart in the centre (see Figure 136). Where the vibration is very long sustained the reversal may reach from pole to pole. Instead of being parallel to the slit the image of the spark or arc may be thrown across the slit, as shown in plan, "KNOWLEDGE," January, 1914, Figure 16.

Clearly either the pole or the centre of the arc can be on the slit. If we use the centre, the appearance of a "long line" will then be a wide line, due to the velocity of the centre or core of the arc, and the outer atmosphere, being cooler and consequently not moving so fast, will show a thinner reversed line. The spectrum of some elements, then, consists of long and short lines, some of them with reversal in the centre (see Figure 137). We may also get a spectrum without reversal, as shown in the beautiful example kindly enlarged by Professor Fowler (see Figure 135).

This reversal will explain the broad bands of Sirian stars. The breadth may indicate the temperature of the gas immediately outside the photosphere of those stars. The width of the bands in some cases represents something like two hundred miles a second, indicating an almost inconceivable temperature.

The broadening of these bands cannot be due to the rotation, as there are also the thin lines of other elements. In our Sun's atmosphere calcium shows broad bands. But calcium, as we know it in chemistry, has an atomic weight of forty; yet it is seen high up on the chromosphere, suggesting that the atom is broken up, and this broadening of the calcium may be due to the combined action of pressure and disruption. These are interesting problems as yet unsolved.

XUM

If the explanation of the above phenomena is unsatisfactory this cannot be said of the spectrograms of novae, which we will now try to understand. The evidence seems indisputable that a nova is a third body torn from grazing suns. Owing to the immense distance separating the stars that are nearest the Sun, some astronomers doubt if there are many stellar collisions.

There are, however, fully a dozen agencies, tending to produce solar impact, that probably render grazes some one hundred thousand times more frequent than mere random encounters.

Solar collisions, instead of being accidental and destructive, are probably a law of nature, and constructive. The cosmic sparks struck from clashing suns are probably the most suddenly stupendous phenomena in the whole realm of nature.

Granting that suns collide—and it seems certain by the mass of corresponding phenomena of novae that they do—some of the salient phenomena are not difficult to deduce. A graze of two similar suns must produce a third star that is an exploding sun. The phenomena common to all novae show that these brilliant ephemeral bodies are exploding suns, and the only rational explanation yet given of the mode of production of an exploding sun is a solar collision.

Anyway, it is certain that were a pair of similar suns to collide, so as to graze off, say, one sixth, a nova would undoubtedly be produced. The deduced body would possess all the many characteristics that are the criteria of novae.

THE SERIES OF SPECTRA OF THE THIRD STAR.

The series of spectra of the third star struck from grazing dead or vivid suns would pass from that of an ordinary star through a remarkable series of changes. At birth every atom is above the critical velocity. That is, were the new star all of one element, every atom would be projected beyond the third body's attraction and be dissipated into free space.

But as it consists of many elements two laws of the dynamical theory of gases come into play. At the moment of the encounter the various elements acquire a temperature tending to be proportional to the atomic weight. The atomic weights of hydrogen, helium, and oxygen are respectively one, four, and sixteen, and the temperature of helium will tend to be four times, and that of oxygen sixteen times, that of hydrogen.

As they mix, these differences of temperature tend to equalise. Were they to become the same, then the molecular speed would be inversely as the square root of the atomic weight, that is, helium would move twice as fast as oxygen, and hydrogen twice as fast as helium.

SORTING OF THE ATOMS.

There is thus a tendency for the atoms to sort themselves into a series of ensphering shells, but there are apparently many agencies, such as gaseous adhesion, that tend to prevent this completely happening.

Some of these we must discuss later when we deal with the details of the spectrograms. At present we will discuss and explain one aspect of the problem, the one that up to quite recent meetings of the Royal Astronomical Society has proved puzzling to astronomers.

This is the fact that the black lines of the elements are displaced so as sometimes to show on Doppler's principle a velocity of approximately a thousand miles a second coming our way ; and these lines die out without lessening displacement.

We have already seen how the series of bright bands of novae have been produced. Some astronomers argue that these are due to pressure, but that is clearly wrong. One has only to look at the fine spectrograms of Nova Persei, made at the Solar Physics Laboratory at South Kensington, in which a comparison star is included, to see that the widening of the bright bands is on both sides of the black band of the comparison star, to know this widening cannot be due to pressure which extends the spectrum towards the red. In "KNOWLEDGE," September, 1911, Figure 7, a portion of one of these spectrograms was given that shows this fact in both the two bands copied. The same fact is shown by the Huggins' spectrogram of Nova Aurigae compared with the solar spectrum in their atlas of representative spectra. These bright bands are really sufficient evidence of expanding spheres, but when we come to treat of the tremendous displacement of the black lines the evidence for the theory of an exploding Sun is conclusive. In "KNOWLEDGE," September, 1911, a full statement of the dynamics of the cosmic spark struck from grazing stellar flint and steel was fully developed ; also in "The Birth of Worlds and Systems," Harper's Library of Living Thought. Sufficient now to say that an ensphering shell of light gases separates from a brilliant nucleus of the heavier elements. The nucleus attains a definite oscillatory volume. The shell or shells expand continually. In Nova Persei this expansion, as indicated by the spectrograms, was at the rate of a thousand miles a second. In Figure 138 the sequence of the phenomena is shown : (a) shows the light gases emerging from the brilliant nucleus. As they are mainly in front of it they produce black bands, which show a little luminosity on the edge towards the red.

Next, the shell as shown has arrived at (b) : all the portion of the shell in front of the nucleus between the parallel white lines on the diagram reverses the light of the nucleus, which is white and gives a continuous spectrum. The remainder of the shell at (b) that is not eclipsed by the nucleus, as it is moving in all directions, gives a broad bright band. As the reversing part of the shell is coming our way we get black bands on the edge towards the violet, as seen in Nova Aurigae as given both by Newcomb and Huggins, and as taken of Nova Geminorum No. 2 at Greenwich and the Imperial

FIGURE 133.

FIGURE 134.

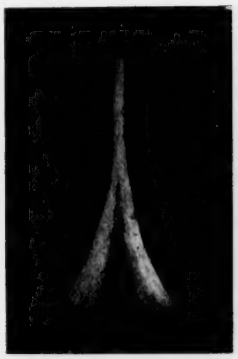


FIGURE 136.

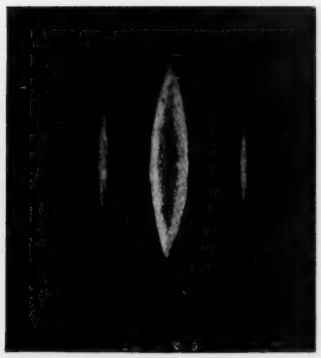


FIGURE 137.

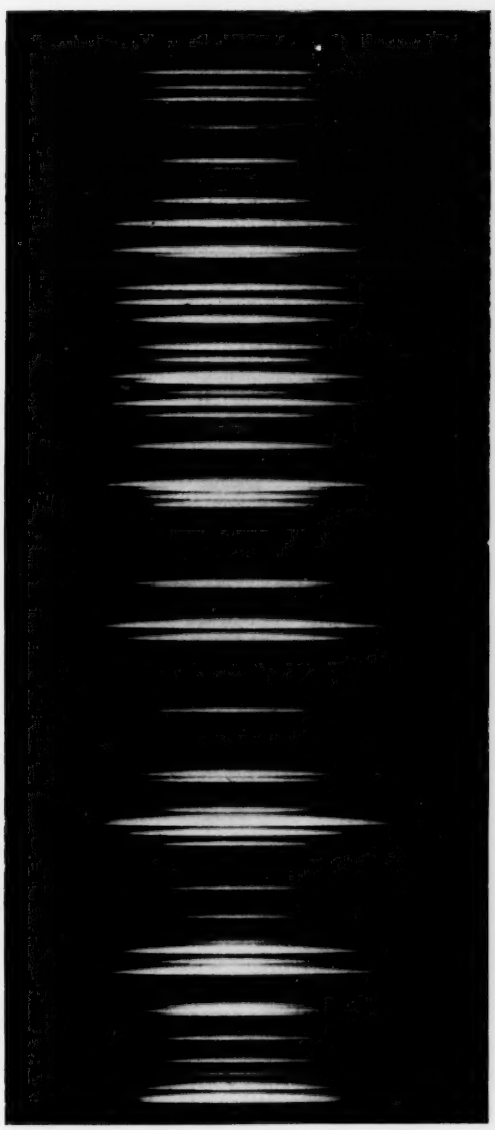


FIGURE 135.

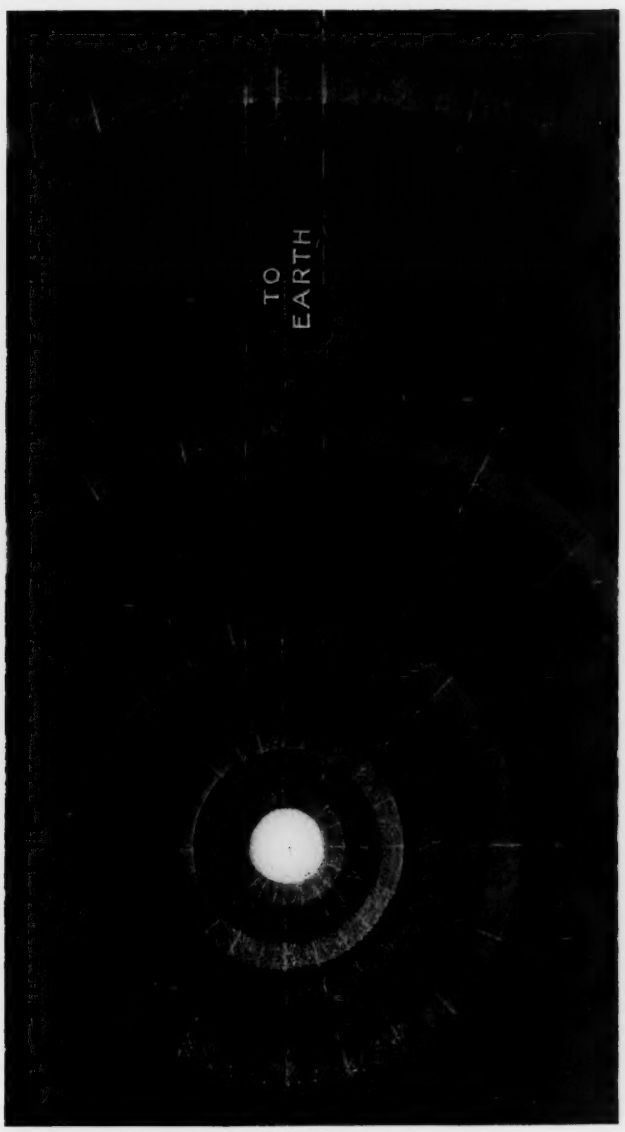
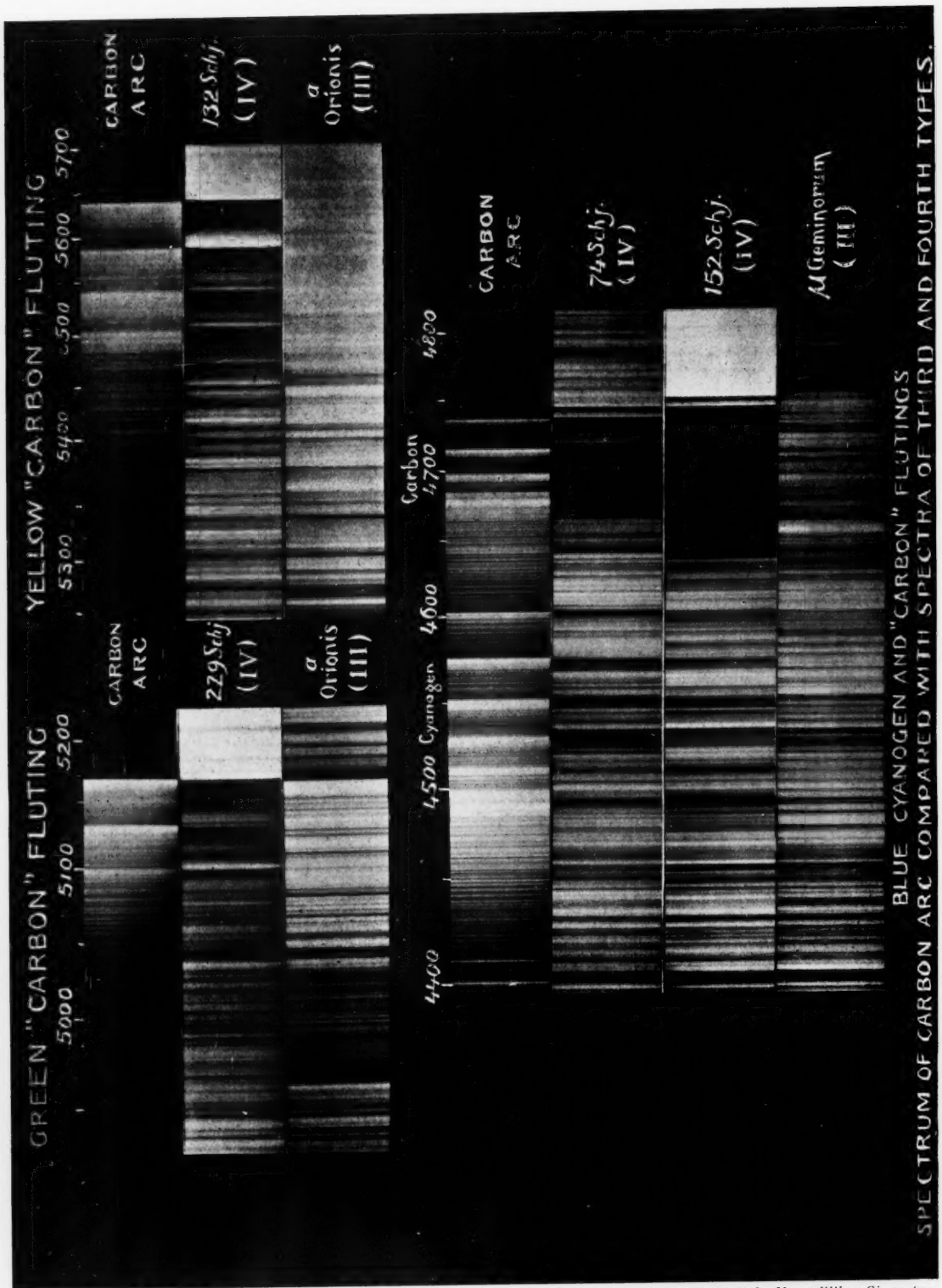


FIGURE 138.



From a spectrogram by *G. E. Hale, Mount Wilson Observatory.*

FIGURE 139.

College of Science. Again we draw the shell still further expanded. The shadow line is narrower, but has the same displacement, because the shell has not appreciably diminished its velocity. It is narrower because the resultant of its velocity differs less. All these peculiarities show beautifully in the spectrograms of Nova Persei.

When I came to England the authorities of the Solar Physics Laboratory kindly gave me a positive of their series of spectrograms of Nova Persei. These so far as above described bore out my theory, but I was disappointed because I had deduced that the shell should as time went on become so attenuated as to have no power of reversal, and consequently the black lines should die out, with lessening displacement, long before the bright bands should disappear (see (c) and (d) of Figure 138).

Then I came into possession of the series of spectrograms by Father Sidgreaves taken at Stonyhurst, and extending to a much later date than the South Kensington series: there was all the evidence I wanted. One saw the thinning of the line to a mere thread, and its disappearance. Several of the later spectrograms show no sign of a black line, much less of anything like a shadow band (see Figure 8, "KNOWLEDGE," September, 1911).

Thus fact after fact backed up the theory, but the deduced physical properties of the third body were many and various. What was my delight to see almost all of them showing themselves, more perspicuously than a written description, in the wonderful Cambridge series of spectrograms of Nova Geminorum, exhibited nearly two years ago in the library of the Royal Astronomical Society. To my great disappointment these spectrograms were not yet available for public use when I last applied for them. When they are so available no trace of doubt that these spectra represent stages in the development of the third star struck from grazing suns can remain in the minds of anyone who can read the spectra and understand the theory of the thermodynamically unstable body that must be formed when stars graze.

Before further developing the details of the spectra of novae we must treat of the spectrograms of the four chief orders of stars and their minor subdivisions.

Already enough has been said on some of their peculiarities to show how many difficult problems the spectroscope has solved, and the marvellous revelation of the wonders of cosmic space it has unfolded.

NOTES.

ASTRONOMY.

By A. C. D. CROMMELIN, B.A., D.Sc., F.R.A.S.

MR. D'ESTERRE'S OBSERVATORY AT TATSFIELD.—I have already alluded to Mr. D'Esterre's work, which affords useful suggestions to amateurs as to lines of research that are likely to prove fruitful. He has selected a limited area of sky (the Milky Way about Perseus and Cassiopeia) and keeps a continuous photographic watch upon it, both with a portrait lens and larger apparatus. He has already been rewarded by the discovery of one possible Nova and many variables. The total area surveyed is one thousand square degrees, or $\frac{1}{41}$ of the entire sky; and as his observations cover three years, he has enough material to lay down the following statistical results: (1) Not more than one in five thousand of stars fainter than the tenth magnitude varies one magnitude. (2) No Novae have been discovered whose maximum brightness is less than magnitude 12. This suggests a strictly limited size for our stellar universe. If it were a million light years in radius (as suggested by Professor See) these faint Novae would be far commoner than bright ones. (3) Faint variables do not disappear at minimum, but remain visible, of magnitude 18 or brighter. This also favours a limited universe. (4) He concludes that the variables are red at maximum, from their visual brightness exceeding the photographic. At minimum the two methods give the same brightness. He suggests that they are very distant, and that the maximum, not the minimum, is the abnormal event in their history.

This comparison of visual and photographic magnitudes is a ready way of determining the spectroscopic type of the fainter stars. For this purpose the visual determination may be replaced by photographs taken with special plates that are sensitive to red. Professor Seares contemplates such a series with the 60-inch reflector at Mount Wilson.

THE PLANET JUPITER.—The Rev. T. E. R. Phillips gave an account of the aspect of this planet in 1913 at the December Meeting of the British Astronomical Association. The peculiarity of the aspect was the number of egg-shaped markings at the northern edge of the great belt in the north equatorial region. These features favoured an accurate determination of the rotation period of this belt. It proved to be unusually rapid, and Mr. Phillips suggested a cyclical variation of period in about thirty-three years. In 1879 the period was exactly 9h. 50m.; in 1889 it had risen to 9h. 50m. 30s., remaining near this till 1900, when it began to diminish; last November it had fallen to 9h. 50m. 10s., so that it seemed to be reverting to the 1879 value.

Herr H. E. Lau gave in *Astron. Nachr.*, No. 4673, an investigation of the variable rotation of the Great Red Spot. An analysis of the observations from 1903 to 1910 led to the conclusion that it had a regular oscillation in a period of 1·9 years; when the results are plotted in terms of this period, they fall along a curve resembling a sine curve, but with a singular flattening from 1·4 to 1·9. In view of the puzzling motion of this spot, I am glad to see that the American Nautical Almanac for 1915 has abandoned the attempt to use this spot as the zero meridian for the temperate zones of Jupiter, and has reverted to the meridian that has been in use in this country for twenty years.

There can be little doubt that the 1·9 year perturbation of the red spot is due to the influence of the dark marking that overtakes it at intervals of this length. Herr Lau has also plotted the longitudes of this marking in a 1·9 year period, and finds a marked disturbance at the time that it is passing the spot, while for the rest of the time the graph is horizontal.

Herr Lau gives some general conclusions as to the condition of Jupiter, which are interesting.

(1) The equatorial diameter at its mean distance is 37″·6, polar 35″·4, compression $\frac{1}{17}$.

(2) The visible surface is a yellow, highly reflective cloud layer: over this there lies a thin layer, whose apparent depth is a few tenths of a second.

(3) The angular rotation in twenty-four hours of the surface layer is 880°·2 at the Equator, 870°·3 at the Poles. The limits of the equatorial current are about 7° north or south latitude.

(4) The limits of this current are the true spot zones. The belts arise as dark spots, which subsequently spread out, both in longitude and latitude.

(5) The bright spots stand over hotter regions of the interior. He considers that their brightness fluctuates synchronously with the period of sunspot activity.

(6) The red spot is an abnormally hot region in the deeper layers of the gaseous interior. The "Bay" encircling the spot arises from the currents in the upper cloud layers, which push back the material of the belt.

(7) The mutual influence of the dark marking and the red spot on each other's motion arises from the streaming of gaseous currents from all sides towards the red spot, where they descend to lower layers.

(8) The disturbances in the motion of the "Bay" arise from the motion of the cloud masses overlying the red spot.

We are apt to forget that the red spot that we see is only an effect of a disturbed region deep down in the planet, and that it does not follow that this deep region shares in all the fluctuations that the surface markings show.

BOTANY.

By PROFESSOR F. CAVERS, D.Sc., F.L.S.

AN ORCHID WITH EXPLOSIVE FLOWERS.—Dr. H. N. Ridley (*Straits Settlements Gardens Bulletin*, Vol. I, 1913, pp. 191–3) describes an orchid from Sarawak which shows a remarkable floral mechanism. This species (*Plocoglottis porphyrophylla*) is widely distributed in Malaya, but being inconspicuous and a lover of deep shade is but little known. It bears only one flower open at a time, but remains in flower for over three months, producing a fresh flower every few days until the raceme is more than two feet long and has borne about fifty flowers. Unfortunately the author's account is not accompanied by illustrations, but the following description may be followed if the reader examines any ordinary orchid flower. In the young flower the ovary begins to twist, as usual in orchids, until it has overtopped the bract : it carries the swelling bud through about seventy-five degrees and then stops twisting. During this twisting the dorsal sepal outgrows the other two sepals and pushes over the apex of the bud. All the sepals at this stage are similarly narrowly ovate, the lateral ones asymmetrically so. The lateral petals are linear and curved round the column to meet at their tips. The lip is about as broad as long, cuspidate above its broad shoulders, with the margins in the lower part frilled and turned under —if these margins are uncurved it is seen that they are the lateral lobes of the lip. Under each broad shoulder a wart has begun to form. Between this stage of the bud and maturity the following changes occur. The contiguous halves of the lateral sepals thicken from the middle upwards ; the cuspidate tip of the lip turns back, its shoulders enlarge, and the warts become sharp little upstanding cones, while the side lobes increase along their margins so that they are too full for the space they have, and towards the base of the lip tend to form an upstanding rounded crest : two very fleshy staminodes lie within the curve of this crest, one on each side. In opening, which occurs in late afternoon or early evening, a slit appears between the lateral sepals ; then these sepals break away and slowly take up a position at right angles to the ovary, and their thickened areas become convex inwards and throw the thin parts back ; then the lateral petals rapidly elongate, curving over strongly so that their points pass between the bases of the lateral sepals, and in this curious action they deflect the lip on to its base, holding it down against a certain amount of resistance, in contact with the lateral sepals ; thus the flower gapes somewhat. During the night the dorsal sepal turns back and the lateral petals straighten. The upper lateral sepal, no longer held away from its fellows by the lateral petals, now moves down to be in contact with it, and is thus almost median as regards the lip, and as the lateral sepals move away, the lip is caught against its convex swelling and held folded down as the lateral petals placed it. A touch now frees the lip and causes it to spring up against the column. It is apparently fertilised by rather small insects which, attracted to the flower, are trapped by the upspringing of the lip against the column, and in struggling to free themselves effect pollination. The mechanism is very curious : the lip is a trigger put into place by the lateral petals and held there by one of the lateral sepals. This alone makes it of unusual interest, but this is heightened by the angle at which the flower stands, by the movement out of the median line of the column, and by the movement toward it of a lateral sepal. The flower has apparently no scent and no free honey : its colours are lemon-yellow to yellowish-green with deep crimson markings on the lip, and the swollen parts of the lateral sepals are maroon.

MARINE VEGETATION OF THE ADRIATIC.—Schiller (*Urania*, Bd. 6, 1913, pp. 382–386) gives a general account of the more striking botanical results of the recent joint Austrian and Italian survey of the Adriatic. He distinguishes three vertical zones of marine vegetation in this sea. (1) Littoral zone, down to low-tide mark, with *Enteromorpha*, *Bangia*, *Porphyra*, *Fucus*, and so on. (2) Sublittoral zone, from low-tide mark to about forty metres depth, with *Bryopsis*, *Cladophora*, most of the Phaeophyceae, *Callithamnion*, many calcareous Algae, and so on. (3) Pelagic zone, down to two hundred metres—this zone presents several features of interest in the Adriatic. Practically no attached Algae are found at any great depth in this sea, the floor of which is very muddy, though down to about one hundred and sixty metres there is an abundant vegetation of calcareous Algae which provides a firm substratum to which are attached such plants as *Laminaria*, *Calophyllis*, and so on. Practically the only plants attached in the loose material of the bottom, and then only near the coast, are *Zostera* and *Posidonia*, which, owing to their roots and rhizomes, are able to colonise sand and mud.

Though some of the Algae show continuous growth, that of the majority is limited to a few months, the periods of activity of the algal vegetation being (1) from the beginning of February to the end of May, (2) from the beginning of October to the middle of November ; hence there is a summer and a winter resting period. Further observations are being made with reference to this periodicity, the causes of which remain obscure. Diatoms are abundant as epiphytes on other plants at all depths, as well as in the plankton, and the latter (chiefly found in the upper seventy metres of water) is very varied, including Peridineae, Coccolithophoridae, Flagellata, and Silicoflagellata. The plankton shows the same general periodicity as the attached vegetation, its maxima and minima occurring in the same months. The author compares the vegetation of the Adriatic with that of the Baltic near Kiel, and notes that the former is relatively poor in quantity, especially as regards the plankton, which is only about half as abundant.

VEGETATION OF THE ARCTIC-AMERICAN ARCHIPELAGO.—Simmons (*Lunds Univ. Årsskr.*, 1913, 183 pp., 2 maps) summarises the botanical results of the various exploring expeditions to the archipelago lying to the far north of the American continent, and shows that this may be divided, both geographically and geologically, into several island groups. The climate is very dry, the annual precipitation in Ellesmere Island, for instance, being less than one centimetre. This is evidently the reason for the very slight glaciation of the area at the present day, and from the absence or slight traces of former ice-covering it is inferred that similar conditions existed during the Glacial period, when the adjacent portion of the continent was covered by a great inland ice-sheet. The author gives tables of temperature observations in different parts of

the area and lists of the plants recorded, with their habitats. He notes that it is hardly possible to distinguish between calciphilous and calciphobous species in this region, and that the poverty in species of the flora in Silurian rock-soils is probably attributable to the dysgeogenous nature of the Silurian limestone. The absence of endemic species is regarded as proof of the complete expulsion of the pre-Glacial flora (the present-day circumpolar species) during the Glacial period and their subsequent return in Postglacial times. In discussing the means by which the archipelago was populated after the Glacial period, the author points out that marine drift probably played a very small part, and that ice was important only in so far as seeds are readily carried by wind over the frozen water-surface separating the various islands. The flora consists mainly of perennials, and over ninety per cent. are adapted for wind-dispersal; the few species with fleshy fruits are chiefly distributed by ptarmigan.

The view that the Arctic-American archipelago was denuded of plant-life during the Glacial period is, the author claims, confirmed by geological evidence. During this period the frozen polar sea was surrounded by land, but later, owing to land sinking, this sea became connected with the open sea to the south. The ice melted first in the western portion, so that the return of vegetation took place from west to east along the coast of the mainland and over Banks Land and Victoria Land; the western element forms a considerable part of the flora of the archipelago and of Greenland. Later the Keewatin ice-sheet retreated so far eastwards that plants could colonise King William Land and Boothia Felix. Still later, when the land between the Keewatin and Labrador ice-sheets became ice-free, plants migrated northwards along the western shore of Hudson Bay, and others came from the south (from eastern North America) via Labrador and Hudson Strait to Ellesmere Land and Greenland when the Labrador ice-sheet melted. The flora of Greenland consists largely of American species; even in East Greenland more than half of the species are American, while the flora of Ellesmere Land is entirely American. That the entire Greenland flora is of Post-glacial origin is indicated by the presence of only four endemic species.

VEGETATION OF THE FALKLAND ISLANDS.—Skottsberg (*Sven. Vet. Akad. Handl.*, 1913), who has done so much in the investigation of the ecological plant geography of far southern lands, published in 1909 an account based on his first visit to the Falkland Islands, and the present paper is the result of a second and longer stay there. The Falkland Islands, an outlying portion of the British Empire, form a group of about two hundred islets off the east coast of the southern end of South America, with a total area of about six thousand five hundred square miles, of which the two chief islands, East Falkland and West Falkland, make up over five thousand. The islands of this archipelago are mostly mountainous—the highest point, Mount Adam, is about seven hundred and fifty metres—with much indented coasts, the climate is cold and wet, wheat will not ripen, and there are no trees—the tallest native plant is a woolly ragwort (*Senecio candicans*) about 1·5 metre high. Much of the interior is covered by thick peat formed largely from *Empetrum rubrum*. The total native vascular plant flora includes one hundred and sixty-two species. Of these one hundred and thirty-three are common to South Patagonia and Tierra del Fuego, fifteen are endemic, and fifteen form a "thermophile" element, since they occur mostly in South Chili and some also in North Patagonia, but not in South Patagonia or Tierra del Fuego. Among the new species described for the Falklands there are several ferns previously known only from the west coast of South Chili and Tierra del Fuego: these appear to be limited in the Falklands to the West Falkland island, which is milder and wetter than East Falkland. Some species in the Falkland flora are limited to the West island (twenty-four) and others to the East island (thirty).

From the geological and botanical results obtained by the Swedish expeditions it would appear that in the Tertiary period the Falkland Islands were less widely separated from the mainland than now, and were probably connected with it. Moreover, though no equivalent of the Magellan *Nothofagus*-beds is known in the Falklands, the latter have yielded Preglacial remains of *Podocarpus*, cf. *salignus* and *Libocedrus*, cf. *chilensis;* and since these species at the present day do not occur on the mainland farther south than the forty-fifth parallel it is probable that shortly before the Glacial period the Falkland climate was warmer than it is to-day. It does not appear probable that the islands were ever extensively forested; indeed, the author considers that the general character of the vegetation has remained unaltered from Preglacial times, and that, though the cold resulted in the killing out of the trees and the establishment of tundra conditions, many species survived the Glacial period, while others (especially the thermophilous forms) were immigrants from the west in Postglacial times, when the climate of Tierra del Fuego was warmer than now. The grazing of sheep and other forms of cultivation have greatly influenced the native vegetation; for instance, the coastal tussock formation of *Poa flabellata* has been largely destroyed.

The climate of the Falklands is more oceanic than that of the neighbouring Tierra del Fuego coast, with more uniform distribution of rainfall through the year; the summer is cooler and the winter milder. The absence of trees is attributable to the strong winds, the configuration of the islands being such that no part is sheltered from the wind. The normal climatic formation is the *Empetrum* heath, but there are also extensive associations dominated by the Umbelliferous cushion plants *Bolax* and *Azorella*, and by the grass *Cortaderia*. The *Empetrum* heath forms a counterpart of the North Atlantic heath in Scotland, the Faroes, and West Norway; the *Bolax* heath resembles the alpine associations in Tierra del Fuego and Kerguelen with *Bolax* and *Azorella* dominant. The *Cortaderia* association also occurs in South Georgia, and in his earlier work on the Falklands the author termed it a steppe, but he now considers that it is better described as a meadow association. The author gives interesting notes on the vegetative characters and the flowering of the various species, with special reference to periodicity, and classifies the plants according to their "biological types." An account of Raunkiaer's "biological types" or "life forms" among plants—one of the most interesting recent contributions to plant ecology—is given by Dr. W. H. Smith in the *Journal of Ecology* (Vol. I, No. 1, 1913). The most important of the latter are the hemicryptophytes (fifty-five per cent.) and the chamaephytes (thirty-one per cent.), but the author points out that the census hardly supports Raunkiaer's characterisation of the Falkland flora as the expression of a "chamaephyte climate," and that the important point is, not merely the large percentage of chamaephytes and hemicryptophytes, but the fact that both classes are evergreen in the Falklands. Thus, while the flowering of the Falkland plants shows marked periodicity, none flowering in winter, there is very slight vegetative periodicity, since most of the plants are evergreen, and simply show arrest of growth in winter.

CHEMISTRY.

By C. AINSWORTH MITCHELL, B.A. (OXON), F.I.C.

THE SOLUBILITY OF CALCIUM CARBONATE.—In a paper read before the Institute of Water Engineers on December 13th, 1913, Mr. W. T. Burgess calls attention to the influence of the solubility of calcium carbonate upon processes in which lime is used for softening water. The bulk of the carbonates of calcium and magnesium, to which the temporary hardness of water is due, is kept in solution by the carbon dioxide which is also present. When the water is boiled the carbon dioxide is expelled and the carbonates are deposited. The same effect is produced

by adding a calculated amount of lime to the water, so as to combine with the carbon dioxide. Mr. Burgess, however, points out that the lime-softening process does not effect the removal of the whole of the calcium carbonate, since water that is quite free from carbon dioxide will dissolve one and a half parts of calcium carbonate per one hundred thousand. Moreover, the separation of the calcium carbonate does not take place so rapidly as is sometimes supposed; for, even where the precipitation appears to be complete, a slow deposition of crystalline calcium carbonate may continue for several days; and the more completely the water is softened the longer the time that should be allowed for subsidence in the tank. Neglect of this precaution may lead to the deposition of calcium carbonate in the mains. To obviate this in cases where it is essential to use the water soon after softening, a small quantity of carbon dioxide may be introduced into the water. As little as 0·3 part of carbon dioxide per one hundred thousand parts of water will prevent this after-precipitation of calcium carbonate in the pipes.

The same difficulty would be likely to occur in using Dr. Houston's process of sterilising water by adding an excess of lime and subsequently removing this excess by the addition of carbon dioxide or sodium bicarbonate. The last portions of the precipitated calcium carbonate would subside so slowly that there would be risk of deposits forming in the water-mains unless a precaution such as that described were taken.

SULPHURETTED HYDROGEN FROM ARTIFICIAL GRAPHITE.—A specimen of the artificial graphite manufactured by Dr. Acheson was found by Messrs. Woodcock and Blount (*Analyst*, 1914, XXXIX, 67) to possess the curious property of emitting sulphuretted hydrogen when broken or scratched with a knife. The material, which was soft and "greasy" to the touch, contained 0·11 per cent. of sulphur and 0·20 per cent. of ash, consisting of silica, aluminium, iron, calcium, and magnesium. The microscopical appearance closely resembled that of ordinary natural graphite, and experiments in which the material was heated in a current of hydrogen proved that the presence of the sulphuretted hydrogen was not due to any occlusion of gas within cavities. Eventually it was found that the gas must have originated from an unstable aluminium sulphide of the type Al_2S_3, which was decomposed by moist air, but was protected from such action until it was exposed by the fracture of the surface of the material.

SOAPS FROM NAPHTHENIC ACIDS.—The increasing demand for fats suitable for manufacture into food-products is leading to many curious developments in the soap industry. Among the more important changes that have taken place is the steady decline in the use of coco-nut oil, which for so long a time has formed the basis of soaps that would produce a good lather and could be used with salt water. Scientific methods of purification have succeeded in removing from this fat the constituents to which it owes its pronounced odour and flavour, and in consequence coco-nut oil has become one of the chief components of margarine, vegetable lard, and butter substitutes. The commercial result has been that very little of the fat is now available for technical purposes, and the price has increased enormously. For example, the crushed coco-nut kernel, or copra, which a year or two ago was sold at £12 per ton, now fetches four times as much, and there seems little chance of its falling again.

Another fat which has hitherto been almost exclusively used for soap is palm oil; but recent improvements in the methods of obtaining the oil have led to the production of a fat sufficiently free from acidity to be used as a food, and it appears probable that before long the demand for edible fats will also absorb this source of supply.

The place of coco-nut oil and palm oils as materials for the manufacture of soaps with good lathering properties has to some extent been taken by soaps prepared from naphthenic acids. These acids are separated as by-products from the waste lyes left in the refining of petroleum oil. They are used as preservatives for wood, as solvents for resins, and as substitutes for turkey-red oil in dyeing; but their principal application, especially in Russia, is in the manufacture of soap.

As naphthenic acids have many physical characters in common with the fatty acids of coco-nut oil and palm-kernel oil they may be used for similar purposes. Thus it has been shown by Dr. Davidsohn (*Zeit. angewandt. Chem.*, 1914, XXVII, 2) that their molecular weights are almost the same. The soda soap requires even more salt than coco-nut or palm kernel oil soaps for separation, the comparative figures being coco-nut oil soap, 13·1; palm-kernel oil soap, 10·9; and naphthenic acid soap, 20·9. It is thus particularly suitable for all purposes where good lathering properties are essential, such as, for example, for use with sea water.

ENGINEERING AND METALLURGICAL.

By T. STENHOUSE, B.Sc., A.R.S.M., F.I.C.

NOMENCLATURE OF ALLOYS.—The Committee appointed by the Council of the Institute of Metals to consider the question of the nomenclature of alloys, as raised by Dr. W. Rosenhain, presented its first report to the Annual General Meeting of the Institute, held in March. The difficulties of the problem were fully recognised, and, after much discussion, it was decided that the only principle of sufficiently wide applicability upon which a rational or systematic nomenclature could be based was that of naming alloys according to their chemical composition by weight, the names of the component metals being placed in the order of increasing numerical importance. Thus an alloy containing three per cent. of copper and ninety-seven per cent. of aluminium would be called "copper-aluminium," and one containing ninety-two per cent. of copper and eight per cent. of aluminium would be called "aluminium-copper." With alloys containing more than three metals this principle leads to a considerable degree of cumbrousness, and therefore certain modifications are proposed to overcome this difficulty. Besides establishing this rational system of names, the Committee have approached the task of defining, in its terms, the ordinary names of alloys intended for everyday usage. Thus "brass" is to be used as an abbreviation of the name "zinc-copper," and an alloy containing tin one per cent., zinc twenty-nine per cent., and copper seventy per cent. will be called "tin-brass." Similarly "bronze" is to be used as an abbreviation of the words "tin-copper" as employed in the systematic nomenclature. In the present report the Committee have defined only these two practical alloy names, but they hope in the next report to put forward a considerable number of "practical" names.

THE ESTIMATION OF ZINC IN COINAGE BRONZE BY VOLATILISATION.—In a paper read before the Society of Chemical Industry Dr. T. K. Rose described an extremely interesting old furnace-method of determining zinc in coinage bronze. It was used many years ago at the Royal Mint, but was allowed to pass out of use in 1870, probably because the temperature was often too low to be efficacious. Its origin is unknown. The method consists simply in heating the bronze in a carbon crucible, driving off the zinc by volatilisation, and weighing the residue. The old crucibles are still used. They are made of gas carbon, and are hexagonal prisms outside, about 2·2 centimetres across and 2·2 centimetres in height. A receptacle for the bronze is hollowed out inside, 1·1 centimetre in diameter and 1·5 centimetre deep, and is provided with a closely fitting lid. The crucibles, each containing one gramme of bronze, are placed close together inside a salamander crucible, and completely covered by powdered charcoal. The cover pot is then strongly heated for two hours in an ordinary gas-injector furnace. The final

temperature has been found to be 1375°C., the boiling point of zinc being 905°·7 C. Dr. Rose has recently tested the process, and finds it trustworthy and useful, if due precautions are observed. The high temperature is absolutely necessary. Attempts to drive off the zinc in a gas assay-muffle urged to the highest attainable temperature—about 1200° C.—proved unavailing. In two hours in the muffle furnace the loss of weight was insignificant.

GEOGRAPHY.

By A. STEVENS, M.A., B.Sc.

THE NEBULAR HYPOTHESIS.—Students of cosmogony will read with interest an analysis of gravitational instability and the nebular hypothesis by Mr. J. H. Jeans (*Phil. Trans. Roy. Soc.*), Series A, Vol. CCXIII, pp. 457-485. Analyses of rotating astronomical matter have been hitherto based on the assumption that it is homogeneous and incompressible. This condition is purely ideal, for, as the author of the paper remarks, primordial astronomical matter must be extremely heterogeneous and compressible. Density and pressure must vary independently of each other and with variation of temperature and chemical composition. No general theory can be given to cover such conditions, but definite problems may be examined, and, as Mr. Jeans shows, the results of these examinations indicate that the older analyses with their theoretical assumptions supply remarkably correct information and guidance. For the case in which the pressure is a function of the density when there is no rotation and the boundary is spherical he arrives at Laplace's solution:

$$\rho = A_0 r^{-\frac{1}{2}} J_{\frac{1}{2}}(\kappa r) = \frac{A_0}{\sqrt{\frac{1}{2}\pi\kappa}} \frac{\sin \kappa r}{r}.$$

For a solution in the case of small rotation, assumptions not generally admissible are necessary; but the problem of rotating cylindrical masses is found to be amenable to analysis and to be useful. Rotating nearly spherical masses with high internal temperature are also dealt with. The conclusions reached on an admittedly partial discussion are found to be generally in accord with those of the earlier investigators. Slow rotation gives flattened configurations similar to those of Maclaurin's spheroids passing into forms like the ellipsoids of Jacobi.

SEISMOLOGY.—In the *Comptes Rendus*, Vol. CLVIII, No. 6 (9th Feb., 1914), M. de Montessas de Ballore discusses the results of modern seismology. In the eleven years, 1899-1909, eight hundred and eighty-one megaseisms were registered by means of horizontal pendulums at fifty-nine observatories, and the results were very homogeneous. The number of more or less destructive earthquakes, that is, of megaseisms directly observable on land, is thirty-one, or one-third of the mean number occurring annually. This is in accord with the ratio of land to sea, and the inference is that submarine tremors are about as frequent as terrestrial. Milne states that thirty thousand sensible shocks occur every year; a thousand times as many as destructive earthquakes. For the whole surface of the globe the annual number of appreciable tremors is eighty thousand. The Pacific, between 120° E. and 60° W., that is, the water hemisphere, encloses 80% of the epicentres: 42% in the west and 35% in the east. These are the two most important seismic areas of the globe. So far as the relief of the ocean bed is known, the same relation is recognised between it and earthquakes as holds on land. In both cases the degree of seismicity corresponds with the geologic history. It may be noted that seismic conditions in the coral seas seem to this author to be in opposition to the Darwinian theory of the formation of coral reefs.

IS THE EARTH DRYING UP?—Professor J. W. Gregory discussed this question at the meeting of the Royal Geographical Society on December 13th last (*Geog. Journ.*, Feb.—Mar., 1914). He enumerates three forms of the Desiccation Theory. Prince Kropotkin holds that the data indicate a steady progress in the climate towards drought, with possible fluctuations in the advance. Professor Ellsworth Huntingdon's view is that there is alternating desiccation and humidification sufficient to produce profound changes in the political and economic situation, but that the resultant tendency is towards drought. The third form is that there are long climatic cycles, and that the Earth is now approaching a maximum of cold and dryness which it should reach, according to Mr. R. Thirlmere, about A.D. 2300. Professor Gregory's examination of the vast collection of evidence leads him to the conclusion that there has been no general and profound climatic change within the historic period comparable to the widespread changes which undoubtedly occurred in late geological times. The change from the climate of the Glacial period, he believes, took place mainly in two ways. In some parts the temperature has risen gradually and the humidity increased or decreased; in others the period immediately post-Glacial was warm and dry, but the humidity gradually increased. The latter has been the mode of change in Scandinavia, Germany, Hungary, Rumania, the south and east of North America, parts of Africa from Nigeria to Cape Colony, and possibly in England. For the desiccation of Asia there seems to be as much weight of evidence as against. Professor Gregory suggests that the explanation may appear when the Eurasian continent is taken as a whole. In Asia the desert is increasing in some parts and contracting in others, while a counterpart to the decrease in total rainfall over Asia is found in its increase in Europe. "Variations in the distribution of rainfall must result from any considerable alteration in the level of the land; the uplift of a continent must cause the rainfall to become heavier on the margins and lighter in the interior. The increase of rain on the coast lands would, however, hasten their lowering by denudation, and again the rain would sweep over the interior; hence that marvellous geographical equilibrium which has rendered possible the unbroken course of evolution would in time, unless checked by renewed uplifts of the coast lands, restore the more even distribution of the rain and revive the desolate regions in the heart of a continent."

GEOLOGY.

By G. W. TYRRELL, A.R.C.Sc., F.G.S.

THE RÔLE OF WATER IN VOLCANIC ACTIVITY.—The views of Brün (discussed in "KNOWLEDGE," September, 1911, p. 352), that volcanic eruptions are essentially anhydrous, receive emphatic refutation in a paper, by Day and Shepherd, on "Water and Volcanic Activity" (*Bulletin of the Geological Society of America*, Vol. XXIV, 1913). This work is based on the study of gases collected from the volcano of Kilauea in pursuance of an extended scheme of study promoted by the Geophysical Laboratory of Washington. Much of Brün's argument depends on the observation that dewpoint readings taken inside the white cloud emitted from the volcano are actually less than those taken in the clear air outside. Day and Shepherd show that the cloud is composed of minutely divided particles of sulphur (not crystalline chlorides, as supposed by Brün), around which water may condense. Furthermore, the partial oxidation of the sulphur would produce the dioxide and trioxide, both of which are effective drying agents. It is therefore "a matter of grave doubt whether the readings of a dewpoint hygrometer in an atmosphere containing SO_2 and SO_3 have any significance whatever in view of the well-known affinity of these compounds for water." Successful attempts were made by Day and Shepherd to collect the volcano gases before they had reached the air. In the first attempt no less than three hundred c.c. of water accumulated in collecting tubes of ten litres capacity. Although, owing to the

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method of collection, this does not represent the proportion of water to the total quantity of volatile matter discharged from the volcano, it proves beyond doubt that these gases contain original water. Analyses of the gases collected shows that the Halemaumau crater yields nitrogen, water-vapour, carbon dioxide, carbon monoxide, sulphur dioxide, free hydrogen, free sulphur, with chlorine, fluorine, and perhaps ammonia, in comparatively insignificant quantity. After the most critical examination the nitrogen was found to be free from argon and other rare gases. This affords a good proof that the volcano gases were collected before contact with air, and that volcanic nitrogen is not of atmospheric origin.

METEOROLOGY.

By WILLIAM MARRIOTT, F.R.MET.SOC.

RAINFALL AT NOTTINGHAM.—A very elaborate and valuable report, entitled "The Meteorology of Nottingham," is prepared annually by Mr. A. Brown and Dr. Boobbyer. In the last report they give a table of the rainfall for the past forty-seven years, 1867 to 1913. The values, which are very instructive, are as follows:—

Year.	Rain-fall.	Year.	Rain-fall.	Year.	Rain-fall.	Year.	Rain-fall.
	in.		in.		in.		in.
1867	**29·90**	1879	**27·31**	1891	**25·89**	1903	**32·37**
1868	**25·33**	1880	**35·45**	1892	*21·58*	1904	*19·73*
1869	**27·75**	1881	**27·49**	1893	*20·17*	1905	*20·01*
1870	*17·93*	1882	**34·38**	1894	*20·25*	1906	*23·94*
1871	**26·83**	1883	**30·05**	1895	*20·75*	1907	**25·65**
1872	**35·90**	1884	*20·10*	1896	*22·99*	1908	*22·70*
1873	*20·51*	1885	**26·66**	1897	*23·73*	1909	**26·05**
1874	*18·14*	1886	**31·76**	1898	*19·75*	1910	**26·55**
1875	**31·71**	1887	*15·64*	1899	*22·64*	1911	*19·79*
1876	**29·31**	1888	*19·99*	1900	**28·53**	1912	**31·14**
1877	**28·77**	1889	**25·61**	1901	*20·44*	1913	*22·46*
1878	**28·84**	1890	*17·70*	1902	*21·52*	—	—
Mean	26·74		26·01		22·35		24·58

The greatest rainfall was 35·90 in. in 1872, and the least 15·64 in. in 1887, the average rainfall for the whole period being 24·93 in.

By printing the values in two kinds of type, those in thick type being above the average and those in italic being below the average, it will be seen that during the first half of the period there were only seven instances with the rainfall *below* the average, while during the second half there were only seven instances with the rainfall *above* the average. Another important feature brought out by the figures is that the mean rainfall for the first half of the period (twenty-four years) is 26·38 in., while the mean for the second half of the period (twenty-three years) is only 23·42 in., a difference of 2.96 in.

This brings out very strongly the absolute necessity for reliable averages of rainfall to be based on a long period of observation, otherwise an entirely misleading result may be obtained, and this may lead to disastrous consequences if the water supply of a town be dependent on the same.

The late Mr. G. J. Symons, F.R.S., arrived at the following conclusions with regard to limited fluctuations in the yearly rainfall: (1) The wettest year will have a rainfall nearly half as much as the average; (2) the driest year will have one-third less than the average; (3) the driest two consecutive years will each have one-quarter less than the average; and (4) the driest three consecutive years will each have one-fifth less than the average.

THE GREAT HEAT AND DROUGHT OF LAST SUMMER IN THE UNITED STATES.—Mr. P. C. Day has given in the *Monthly Weather Review* for September, 1913, an account of the intense heat and drought which prevailed last summer over a large portion of the United States. From this we learn that about the middle of June unusually warm weather set in over nearly all portions of the country to the eastward of the Rocky Mountains, with the centre of greatest temperature excess above the normal in the middle portions of the Great Plains and Mississippi Valley. With but slight interruptions, this unusually heated condition continued over these districts and adjacent regions until near the end of the first decade of September. During this entire period of about twelve weeks of almost continuous excess of heat, dry weather also prevailed in the same region with more or less severity, which, with almost continuous sunshine, frequent hot winds, and deficient humidity, combined to produce one of the most disastrous seasons in the history of the region affected.

The month of August, as a whole, was one of the warmest ever known in the middle West, the heat exceeding in some of the States that of July, 1901, which has generally been accepted as the warmest month ever known in the United States, save in the desert regions of the South-West. In Kansas the average maximum temperature in July, 1901, was 100°·9, while for August, 1913, it was 101°·5. Notwithstanding this increase in the day temperature, the nights were cooler than those in July, 1901, the average minimum temperatures being in July, 1901, 69°·3, and in August, 1913, 67°·3, a difference of 2°. The average daily range was therefore 2°·6 greater during August, 1913, than during July, 1901. The highest temperature registered during the period was 116° at Farnsworth, Kansas, on July 11th, and several stations reported as high as 113° in both July and August. The station reporting the highest mean maximum temperature was Clay Centre, Kansas—107° for August—a record doubtless never exceeded in the United States, save only at a few of the hottest points in the desert valleys of South-Western Arizona and Southern California. At the above mentioned point in Kansas the maximum temperatures were 100° or higher each day from August 1st to September 7th inclusive, save for one day, when it rose only to 92°, the average for the period of thirty-eight days being 106°·5, while the total number of days with maximum temperature 100° or above from June 16th to September 7th was 64.

At the same point from July 1st to September 8th, a period of seventy days, the precipitation was but 0·03 inch, a record likewise unsurpassed for the principal crop-growing season in the history of the State. Wells and springs dried up that had never previously failed, and streams were in many cases the lowest on record, the observer at Ottawa, Kansas, reporting the river at that place as being the lowest in a period of fifty-three years.

PILOT BALLOON ASCENTS AT UPAVON DURING 1913.—At the Meeting of the Royal Meteorological Society on February 18th Mr. G. M. B. Dobson read a paper on "Pilot Balloon Ascents at the Central Flying School, Upavon, Wilts, during the year 1913." These balloon ascents are made with the object of obtaining information which will be of use for pilots in flying. The results given in the paper were based upon ninety-seven ascents. It was found that the direction of the wind veers from, and its velocity increases with, increasing height above the ground until the gradient direction and gradient velocity are reached. The gradient velocity is usually reached at a height of one thousand feet, though the gradient direction is not found until a height of about two thousand five hundred feet. At higher altitudes the velocity tends to increase and the direction continues to veer slightly beyond the gradient velocity and direction. Light winds show little increase of velocity with height, and they do not seem to have quite reached the gradient velocity below

three thousand three hundred feet. Moderate winds attain the gradient velocity at one thousand feet, but strong winds at one thousand six hundred and fifty feet. The increase of velocity is greater for strong than for moderate winds. The increase of velocity with height is much more rapid in the morning than in the middle day, and the increase is greater in spring than in summer. At those times when the velocity increases rapidly with height above the surface the direction also veers comparatively rapidly, and *vice versa*.

The majority of the ascents were followed by one theodolite only, as twice the amount of time would be required for working out the results if two theodolites were used.

WEATHER MAP OF THE NORTHERN HEMISPHERE.—With the commencement of this year the United States Weather Bureau has begun the publication at Washington of a weather map of the Northern Hemisphere, which is to be printed on the reverse side of the morning weather map of the United States. Although the number of reports available for the construction of the map is necessarily very limited and the times of observation are not all strictly synchronous, nevertheless the essential features of the atmospheric circulation over the Northern Hemisphere are fairly well depicted. The publication of these maps will tend to facilitate and promote the serious scientific study of the great and complex problems of the general circulation of the atmosphere.

On these maps the C.G.S. (centimetre-gramme-second) units are exclusively used, the barometric pressures being given in millibars (1000 millibars = 29·531 inches) and the temperatures on the absolute scale (centigrade), on which the temperature of melting ice is 273°.

The English Meteorological Office has also since the commencement of this year employed these units on the maps given in the *Weekly Weather Report*. It is greatly to be regretted that the ordinary English values are not also given on both these maps, as the vast majority of persons do not know what a millibar is, and probably have never heard of the term. The best method of paving the way for the introduction of the new units would be always to give the corresponding ordinary English values at one end of the isobars and isotherms, and the C.G.S. values at the other end. By this means the equivalents of each scale would soon become known.

MICROSCOPY.

By F.R.M.S.

A NEW ZEISS OBJECTIVE.—In examining blood films we want to know—

(*a*) The relative numbers of the normal types of leucocyte.

(*b*) Whether any abnormal corpuscles are present.

(*c*) Whether any organisms of pathological import are present outside or inside the corpuscles.

As already stated (page 33 of present volume), we can ascertain (*a*) with a fairly low power provided the illumination is good. In order to be sure about (*b*) and (*c*) it is generally desirable to use an oil-immersion lens. I suggested that a $\frac{1}{7}$" immersion might be better than a $\frac{1}{12}$", because of the larger field. Messrs. Zeiss have now produced such an objective. Its N.A. is 0·9, free working distance 0·35 mm., diameter of field of view with Huygenian ocular 2, 0·42 mm. The corrections are equal to those of the ordinary immersion twelfth by the same makers. On examination we find that this objective gives an exceptionally brilliant image—slightly better, in fact, than that yielded by the very best dry lenses when perfectly corrected—the explanation being found in the abolition of the reflecting surfaces. The superiority in brilliance is so marked as to convince anyone that his medium-power objective ought to be an oil immersion. As to definition, the new lens gives surprisingly good detail with the highest oculars. When tested upon coloured objects it is seen not to be apochromatic, but it is the equal of the best achromats. For the purpose of haematology its large field, suitability for use with uncovered preparations, and depth of focus make it quite the ideal objective. The large field enables a differential count to be made in about half the time: the long working distance makes it extremely improbable that the front lens will be injured if ordinary care be used. It gives good photographic results with a screen and panchromatic plate. It can be used successfully for dark-ground illumination. For all ordinary diagnostic purposes it is an efficient medium and high power combined.

E. W. B.

GROUND GLASS LABELS.—With reference to the note in the January issue of "KNOWLEDGE" (page 32), it may be worth mention that carborundum powder will produce a ground surface more quickly than emery. The powder may be purchased at most tool-shops, and costs 1/2 per pound. The FFF grade is the finest, and is most suitable. The same method may be used to produce fine-grained focusing screens for photographic cameras.

H. H. P.

QUEKETT MICROSCOPICAL CLUB.—At the 48th annual general meeting of the Quekett Microscopical Club, held on February 24th, the presidential address was delivered by Professor A. Dendy, D.Sc., F.R.S., who spoke on "Organisms and Origins." An account was first given of the theories current in the early part of the 18th century, explaining the nature and origin of fossils, with especial reference to a "Physico-Theological Discourse," by John Ray, published in 1732. This deals with the occurrence and origin of fossils, which are attributed to the waters of the universal Deluge, "bringing up out of the sea and scattering all the Earth over an innumerable multitude of shells." A friend of Ray's, Edward Lhwyd, M.A., F.R.S., suggested that a *seminium* may be raised with the exhalations from the sea, and falling with the rains and fogs may penetrate the "Chinks and Meatus's" of the Earth and there develop and eventually be petrified.

There are only two possibilities with regard to the origin of terrestrial organisms. Either they must have been imported from some other planet in the form of germs, or they must have developed on the Earth's surface from inorganic materials that formed part of the Earth itself. The theory of Panspermia, due to Arrhenius, was mentioned, and while it was thought possible that the minute germs there postulated might be able to resist the cold of interplanetary space, the fatal effects of the ultra-violet radiations from the Sun would be a most serious objection. Reference was made to the Chlamydozoa, or "filter-passers," organisms so minute as to be beyond the reach even of ultra-microscopic methods, and which certainly have a smaller diameter than 0·000001 millimetre. Yet these organisms are believed to be the cause of certain diseases such as yellow-fever, cattle-plague, rabies, and others. That these diseases *are* due to living organisms, and not to lifeless toxins, is indicated by the fact that a period of incubation always follows infection.

Dealing with spontaneous generation, mention was made of the classical experiments of Pasteur, Tyndall, and others. An account was then given of the recently published work of Dr. Charlton Bastian, who for some of his positive results employed a very dilute solution of pure colloidal silica with the addition of either pernitrate of iron or phosphoric acid and ammonium phosphate. Torulae, bacteria, and even moulds have apparently developed in this observer's tubes in varying quantities. The President said that to a certain extent these results are in accord with purely *a priori* expectations, but in other respects they appear improbable to the last degree. Most of the organisms produced are of well-known types, and one of the moulds formed appears to be a *Penicillium*, producing spores in the ordinary way. It was impossible to believe that such comparatively highly organised beings can have been evolved so rapidly from ultra-microscopic germs. Altogether we may fairly say that the acceptance of Dr.

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Bastian's results would involve us in so many difficulties that it is preferable at present to believe that there has been some error in his mode of procedure, some unexpected loophole through which contamination of his preparations has taken place.

THE CLEANING OF POLYCISTINOUS EARTH.—In the second number of *The Journal of Micrology* the question of cleaning polycistinous earth is discussed by Mr. Thomas E. Doeg. His method is to put small lumps of the material into a boiling-hot solution of acetate of soda. The mixture is then boiled and allowed to crystallise. This process is repeated several times until the lumps are disintegrated to form a muddy deposit. The soda is then got rid of by washing, and any lime and some of the organic matter which is present are removed by boiling in nitric acid. Then there is more washing and another boiling, this time in strong sulphuric acid, to which a small pinch of powdered chlorate of potash is added, from time to time, with great care, and the fumes allowed to pass away up a chimney. The work is not done then. The material must be thoroughly washed again, boiled in a fairly strong solution of soapy water, and finally washed with hot distilled water. Mr. Doeg says that if the material be refractory the whole process may have to be repeated two or even three times.

PHOTOGRAPHY.

By EDGAR SENIOR.

RESTORING TARNISHED DAGUERREOTYPES.—The great number of years which have now passed since the days of the Daguerreotype process has resulted in many of those fine examples of photography becoming more or less marred through the formation of a metallic-looking veil or film, which greatly obscures the image. That this veil may be successfully removed without injury to the picture does not appear to be generally known; and, although the operation is a delicate one, requiring great care, it will, when properly carried out, practically restore the photograph to its original condition. It would not be wise, however, for a novice to practise on a valuable specimen at first; and in no case must anything that is a solvent of finely divided silver or mercury be used, or injury to the image will result; hence cyanide of potassium should be carefully avoided. The best agent for the purpose appears to be pure hydrochloric acid, free most especially from any trace of nitric acid. The Daguerreotype being carefully levelled, a little of the acid is poured over it, when the tarnish will be quickly removed and the image appear bright and clean. Directly this appearance is evident the acid must be washed off under a stream of water from the tap, and the plate finally rinsed well in several changes of pure distilled water. The final operation is the drying of the plate, and this requires to be carefully done in order to avoid markings being apparent on the surface when finished. The operation is carried out by holding the plate by means of a pair of pliers over the flame of a bunsen burner or a spirit lamp, heating one corner rather more than the rest, and then holding the plate in a nearly vertical position with the hottest part at the top. The surface is blown upon in order to ensure rapid and even evaporation of the water. Lastly the restored Daguerreotype should have a glass placed over it, and the whole bound round with strips of paper to exclude the air as much as possible from entering.

THE RAPID DRYING OF NEGATIVES.—Negatives taken on gelatine plates are at a disadvantage compared with those made by the older collodion process with regard to the length of time the former take to dry, whereas a collodion film may be dried in the space of a few minutes by the aid of heat: any attempt to do so in the case of gelatine would be met with fatal results. Any method, therefore, which will with safety accelerate drying becomes at times very welcome. Although high temperature favours rapid evaporation of water, this alone is not of much good without ventilation, for, as air may be saturated at any temperature below that of boiling water, it is necessary that such air be constantly removed and replaced by drier air in order to carry off the moisture, and the higher the temperature of the air the greater the quantity of water it is capable of taking up before becoming saturated. Then, again, the temperature at which the drying takes place should be kept as constant as possible, since any great variation is almost certain to result in patches of uneven density in the negative. Further, the surface water on the film should evaporate evenly, otherwise patches showing a difference in density will be apparent. A defect of this kind is frequently seen in spots about the size of a pea, the film still remaining swollen in these parts when the rest of the plate is practically dry. Trouble of this sort may, however, be avoided by removing the surface water with a piece of cotton-wool, or pressing the palm of the hand, or a soft squeegee over the film, and then gently blotting with soft fluffless blotting paper. Whirling the plate is also to be recommended, as then the surface water is quickly thrown off and the film becomes almost surface-dry in a very short time. Or, better still, place the plate in a bath of alcohol for a few minutes and then whirl, and if two alcohol baths be employed the drying will be greatly accelerated. Negatives that have been soaked, "after removal from the washing tank," in a saturated solution of common alum or in chrome alum can also be dried more rapidly, since, the film having become much harder, a higher temperature can be employed in drying. Then, again, if the negative, be immersed in a ten per cent. solution of formalin for about five minutes the film becomes so hardened that it will bear drying by a fire even without injury. It has also been recommended to add the formalin to the "hypo" bath in order to attain the same end, although personally we prefer to use it after fixing and washing. A consideration of the question of drying formed the subject of a paper read before the French Photographic Society some time back by Messrs. A. and L. Lumière and A. Seyewetz, in which the authors described the use of strong solutions of iodides, chlorides, bromides, as well as nitrates, chlorates, and carbonates as desiccating agents. They further showed that sulphate of aluminium as well as zinc sulphate exerted most complete drying action, and, further, that ammonium sulphite, soda sulphite, and "hypo" behave in the same way. Of the various substances experimented with, however, that in which a cold saturated solution of potassium carbonate was employed was found to give the best results. The affinity of potassium carbonate for water is well known, a method of estimating the amount of water in alcohol being based upon it. When sulphate of aluminium was the substance employed they recommended a one hundred per cent. solution, while in the case of zinc sulphate a one hundred and sixty per cent. was the strength given, while with "hypo" a one hundred per cent. solution was found necessary. In the case of potassium carbonate the following was the formula:—

Potassium carbonate (dry)	90 grams.
Water	100 c.c.

The negative to be treated requires to be immersed in the solution from four to five minutes, after which it is blotted between blotting paper, when the drying is further completed by wiping the surface of the film with cotton-wool or a soft cloth.

ZOÖLOGY.

By PROFESSOR J. ARTHUR THOMSON, M.A., LL.D.

SPONGES IN WATERWORKS.—Professor W. N. Parker discusses the extensive growth of *Spongilla lacustris* in the pipes leading to one of the filter-beds of the Cardiff Waterworks. Some of the branches were eight inches long, and in mid-winter the sponge showed no trace of dying down. It can grow as well in the dark, without zoöchlorellae, as in the light. No trace of larvae or sexual reproduction was seen throughout the year; the production of gemmules

is more than sufficient. Professor Parker recommended that the pipes and chambers should be scraped and treated with strong brine, and this method has been very successful in getting rid of the sponge.

COMPETITION BETWEEN PORTUGUESE OYSTERS AND COMMON OYSTERS.—J. L. Dantan reports that at Arcachon the Portuguese oyster (*Gryphea angulata*) is steadily predominating over the common oyster (*Ostrea edulis*)—a very undesirable victory so far as the fishery is concerned. The Portuguese form is not viviparous like the other, and there is probably even greater mortality in the early stages; but after fixation has been effected the shells grow very rapidly and smother adjacent common oysters.

CETACEAN PELVIC BONES.—To those with some imagination it is impressive to see the pelvic bones of a big Cetacean. Dwindling relics they are of originally large hip-girdles. Sometimes there are remains of a femur and tibia as well, but the pelvic bones are connected only with the adjacent muscles (the tail muscle, the genital muscles, and a trunk muscle). Willy Augustin has recently studied a considerable number of specimens of the pelvis of *Balaenoptera physalus* (the Finner), *B. sibbaldi* (the Blue Whale), *B. borealis* (Rudolphi's Rorqual), and *Megaptera* (the Humpback), and taken very careful measurements. He shows that these vestigial bones are, like many vestigial structures, in a condition of variability. He regards each pelvic bone as equivalent to ischium only. Röntgen photographs showed that the characteristic internal architecture of the bones was still intact.

MEASUREMENT OF INTENSITY OF INBREEDING.—Dr. Raymond Pearl explains in Bulletin No. 215 of the Maine Agricultural Experiment Station (1913) a formula for measuring the degree of inbreeding. The inbred individual possesses fewer different ancestors in some particular generation or generations than the maximum possible number for that generation or for those generations. The measure of the intensity of inbreeding in any generation is the proportionate degree to which the actually existing number of different ancestral individuals fails to reach the maximum possible number. This coëfficient of inbreeding may have any value between zero and one hundred. When there is no breeding of relatives whatever (that is, in the entire absence of inbreeding) its value for each generation is zero. As the intensity of the inbreeding increases the value of the coëfficient rises.

MIGRATION ROUTES.—Palmén, and after him Weismann, advanced, some forty years ago, the hypothesis that the paths which migratory birds follow to-day are the ancient paths by which they extended their range northwards. One of the difficulties is that the spring route is often very different from the autumn route; but it may be answered that secondary divergences may have arisen in the course of time. Sven Ekman has tested the hypothesis recently with reference to *Tringa minuta* (Little Stint), *Totanus fuscus* (Spotted Redshank), and *Limosa lapponica* (Bar-tailed Godwit) in North Scandinavia, and comes to the finding that it does not fit the facts. Yet he thinks it fits the case of geese (*Anser erythropus* and *Anser fabalis*), and that is because the young and the adults fly together. "If a species," he says, "in which old birds and young ones migrate together follows in the course of its migration a route markedly divergent from the north-south direction, and if this divergence cannot be explained by other conditions (such as a similar succession of geographically homogeneous regions), it may be supposed that the migration is persisting along the path of original expansion of range."

CORRESPONDENCE.

HIGH TIDE AT FREEMANTLE.

To the Editors of "KNOWLEDGE."

SIRS,—Assuming that your correspondent, Mr. Gornold, refers to Freemantle on Southampton Water, surely there *are* two high tides there.

In my boyhood, and up to, say, 1878, I spent every summer holiday at Freemantle, and almost lived upon Southampton Water. Provided the wind did not affect matters, we always relied on the second tide to get our small sailing boat over the mud shallows to its moorings.

We paid little attention to the first ebb, because we knew that presently boats moored in the channel would swing round again, with sterns to the River Test, and that then it was time to make for home.

R. SHEPHERD.

CLAUGHTON,
BIRKENHEAD.

HIGH TIDE AT FREEMANTLE.

To the Editors of "KNOWLEDGE."

SIRS,—'Moxly's Theory of the Tides," by J. F. Ruthven (J. D. Potter, 145, Minories; about 1/-), Chapter IX, page 80, appears to be the best article on the subject.

SOUTHSEA. JOHN A. RUPERT-JONES,
Lieut., R.N.R.

CO-OPERATIVE PRODUCTION AND PROFIT SHARING.

To the Editors of "KNOWLEDGE."

SIRS,—In the Supplement to *The New Statesman* of February 14th, "Co-operative Production and Profit Sharing," occurs the following:—

> ". . . the case of the independent producer who works by himself with his own tools on material which he either extracts from the earth or purchases from others, the whole product thus remaining his own property, until he exchanges it for some equivalent received by him. Here we seem to have, in its fullest manifestation, the worker his own master, free from subjection to any man, *enjoying the whole product of his labour.*"

It would be interesting to know the opinion of your economic readers upon the last (and most important) part of this sentence, and which I have italicised.

I am totally at variance with it. Let us take the simplest case where the man works under the conditions indicated, and by the exchange of his produce achieves a standard of living, neither high nor low, but about what is indicated by the productive efficiency of the community in which he lives. He will then be in receipt of nothing answering to the description of "rent" or "profit" (considered as a clear surplus—Mr. J. A. Hobson's "unproductive surplus"). But how will he manage his exchanges? Everything he buys will come to him with the price loaded against him by "profit-cum-rent." Supposing he live in London he will, for instance, buy milk at fourpence per quart. The price *minus* profit and rent is probably about twopence halfpenny. How can he be said to be "enjoying the whole product of his labour," and so on, "in its fullest manifestation"? So far as the illustration serves, he is receiving, not the whole, but merely five-eighths of his product, and he will be in the same case with almost the whole of his expenditure.

G. T. JOLLAND.

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MUSEUMS AND EDUCATION.

By WILFRED MARK WEBB, F.L.S.

(*Continued from page* 91.)

HITHERTO we have spoken in general terms of the contents of a Children's Museum; now we may say something about the specimens which are actually offered as suggestions at the Children's Welfare Exhibition, and their display. The exigencies of time and space have put a very strict limit on what can be shown, and therefore the exhibits will be confined to natural history, chiefly zoölogy. Animals generally attract more attention than plants.

THE LIVING SIDE.—(1) ANIMALS.

As it is hoped that much of what will be on view will be helpful to teachers wishful to have a school museum, an endeavour has been made throughout to choose fittings and apparatus which can be obtained for a small sum of money. For instance, large aquaria and vivaria, specially constructed, are expensive things to buy. On the other hand, square glass boxes, used for storage batteries, are very convenient, if one is content to choose animals suitable for habitations measuring some twelve inches by fourteen inches, and thirteen inches high. This is the size which we have generally used, though somewhat longer ones can be procured.

In the freshwater aquarium the object is to arrange a permanent community, that is to say, a collection of plants and animals so chosen that the amount of carbonic acid gas given off as a result of the breathing of the animals shall be sufficient to provide the plants with this part of their food; while the amount of superfluous oxygen excreted by the plants, when using the carbon to build up starch, shall be enough to supply the animals with what they want for breathing. If a proper balance is established there will be no need to change the water, provided that it does not become foul for any reason.

In the case of marine aquaria, especially in such small ones as have been indicated, it is not so easy to arrange matters. Water in rock pools is changed at each tide, and for the successful conduct of the aquaria it is necessary to provide some artificial means of aëration. Often, a hand-syringe, plied from time to time, will be found sufficient. In some museums, which make a feature of their living side, an air-pump is kept continually at work. This, however, requires an initial outlay of eight or ten pounds, and water or electric power must be provided to keep the pump working.

The apparatus which we have considered more suitable in the present instance is a modification of a very simple contrivance in which, by the continual dropping of water through a tube from one receptacle to another, a flow of air is forced out of the latter into the aquarium. All that is required is two large jars, some glass and india-rubber tubing, some corks, a pinch-cock, a lamp chimney, a wooden tap, and a piece of cane. No continual supply of water is necessary, as that which is put into the apparatus is used over and over again. The labour which is involved consists of drawing off the water from the lower jar and transferring it to the higher one. Where there is a series of jars the addition of a trough, into which the water is discharged from all the lower jars, and an inexpensive semi-rotary hand-pump, which can be connected in turn with the upper row of jars, will render the work much easier.

Turning now to the members of the various groups and classes of the animal kingdom, which may be represented in the living side of the Children's Museum and kept in the receptacles which we have described, we come, first of all, to the Mammals.

MAMMALS.—The class may be illustrated by means of the harvest mouse, the tiny species added to the British fauna by Gilbert White. If some stalks of wheat are fixed into a board at the bottom of the glass box, the mice will climb these slender supports, and, sometimes, construct a nest between them. If these mice are not available others may be used, or one of the voles.

BIRDS.—For birds we shall not be able to use the glass vivaria. As there is no opportunity for caged birds to fly, except in large aviaries, many people do not care to keep them in captivity, though there can be little objection taken to canaries which have been bred in captivity for many generations. A suggestion is made that observatory nesting boxes should be fixed inside the Museum, so that they can be looked into from within, while the birds enter from an opening outside. If such boxes are occupied, not only can the nest and eggs be examined, but the birds actually watched while they are building.

REPTILES.—A goodly number of snakes, lizards, and tortoises can be kept quite satisfactorily in captivity. It is well to show indigenous species of the first two kinds, and some of the smaller and less known tortoises from abroad. The green lizards from the Channel Islands and the Continent, being larger, would want a more extensive enclosure; but there are plenty of smaller foreign species that are imported from time to time into this country.

We ought not to forget the blindworm, an English legless lizard, which soon gets accustomed to being handled.

Amphibians.—For forms which retain their gills we shall have to go abroad. The olm, from the caves of South Europe, lives well in captivity, as does also the American axolotl. This form, though it breeds regularly as a gilled water form, on occasion becomes a land animal, and develops lungs, like the newt. Interesting experiments may be instituted in the Museum to ascertain whether, by gradually restricting the amount of water, axolotls may be induced to make the change. The British newts, like the toads and frogs, go back to the water in the springtime to lay their eggs, but remain there for a longer period. They will be inmates of the aquarium for part of the year.

Frogs and toads will feed well, and become very tame in captivity. The edible frog, which is found in this country, and the natterjack toad will probably be more interesting for exhibition purposes than the common species. There is quite a number of foreign species, too, of small size—tree-frogs and fire-bellied toads—which can be shown.

The land salamanders, which do not need to go to the water, as they produce their young alive, should also be mentioned.

Fishes.—These will be represented, as a rule, by bony fish, and there are plenty of quite small species which can be kept in the battery boxes: the English minnow and stickleback (this latter will, if care be taken to keep a single pair isolated, make its nest and rear its young successfully in aquaria); the bitterling, which lays its eggs in mussel-shells; the umbre, and a number of others. A small pike is interesting, but a larger aquarium will be required. There are also a number of marine fishes which will flourish in aquaria for a considerable time, but here, again, there must be plenty of space at their disposal.

Molluscs.—Examples of bivalves, in the shape of freshwater mussels, of water-breeding univalves, with an operculum or a lid to their shells, such as the freshwater whelks (*Vivipara*), and many of the air-breathing pond snails are common inmates of aquaria. It may here be said that museum jars with flat sides and small battery jars may be used for specimens of one kind of small animal; for instance, freshwater limpets and quite a number of freshwater molluscs can be satisfactorily exhibited in this way.

Molluscoidea.—Lamp shells, being rare marine forms, will not be represented. Colonies of polyzoa are large enough, of course, to be seen in freshwater or marine aquaria, but the individual polyps will only show their full beauty under the microscope.

Arthropods.—Three air-breathing classes of this group can easily be represented—the spiders by the well-known water form, which builds a silken bell below the water, which it fills with air, and in which it lays its eggs. There are many freshwater mites, numerous water-beetles and water-bugs, with a host of larvae of land insects, which pass their early stages in the water. In most cases these are best exhibited in quite small tanks. Where dragon-fly larvae are kept, it is well to have a canopy (with glass on one side and muslin for the roof and the other three sides) over the aquarium. There should also be some sticks or weeds standing above the surface of the water, which will enable the larvae, when it is time for them to change, to crawl up on to the muslin, where the process of the emergence of the dragon-fly can be watched through the glass. Many insects, however, can be kept and reared in vivaria and breeding-cages. An observatory hive is always a source of interest in a Museum, where a suitable place for it could be found. Ants' nests, which can be easily kept between plates of glass, must also not be forgotten; and, going abroad for the moment for material, the ant-lion's pitfall in the sand is calculated to arouse much interest.

The water-breathing division, or crustacea, though chiefly living in the sea, has many freshwater representatives. In marine aquaria we may keep prawns and shrimps, and some of the crabs; in the others, freshwater crayfish, the water-louse, and the fairy shrimp; while many of the water-fleas are large enough to be distinguished.

Worms.—Of the higher worms the leeches live in fresh water, and there are other segmented forms. An attempt should be made to keep some of the tube worms in sea water.

It may here be said that microscopes should be provided in a School Museum, to show the smaller forms of life. Mites and water-fleas, already mentioned, could be demonstrated as well as the rotifers, or wheel-animalcules; some also of the thread-worms, and other lower forms.

The Starfishes and Sea-urchins.—There are no freshwater examples of these forms, but starfishes have been known to live in marine aquaria for some considerable time.

Coelenterates.—Although the little freshwater hydra can just be seen with the naked eye, and is a good microscopic object, it is possible to represent this group very satisfactorily in salt water by means of very beautiful sea-anemones.

Sponges.—Some of the smaller marine sponges should be kept, though the freshwater ones seem to prefer running water.

Protozoa.—Unicellular animals, though they occur in aquaria, will not, as a rule, be visible, except under a microscope.

(2) Plants.

Certain plants will necessarily be used in the aquaria, and some attempt of classification may be made; but in connection with flowering plants

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a useful part of this living side of the Museum is a wild-flower table on which the various plants in flower during the week or month are always on view. Seedlings make a good exhibit in their season, and it should not be difficult to show living examples of flowerless plants illustrating the chief groups and classes.

PRESERVED SPECIMENS.—(1) ZOOLOGY.

There is, of course, an almost inexhaustible amount of material of which educational use may be made. It is only possible here to work out a few ideas. Bearing in mind, too, the question of expense, nothing that needs large cases has been introduced. Wall frames built up on the unit system (each containing six glass-topped boxes) have been used to illustrate certain points. Below the frames, on a shelf in some instances, specimens which may be handled have been put.

It is only intended to show the sort of thing that can be adapted to this method of treatment, and no attempt has been made to illustrate the complete contents of a museum. It is suggested that only a certain amount of material available should be displayed at one time, and an excellent use can be made of what is not being shown by sending it round as a travelling museum when it is not wanted at headquarters.

MAN.—It is always well to bear in mind that man is an animal, and the first three cases suggested, bring out some important ways in which he differs from other members of the kingdom to which he belongs. Specimens in these illustrate man as a tool-maker, as the only fire-making animal, and as a worker generally. The implements give an idea of the stages of culture, and a simple industry, such as straw-plaiting, illustrated in the third case, leads on to what might be a folk side to the Children's Museum.

MAMMALS.—Structure, and the classification which is based upon it, may be shown by the series of specimens under the title "Mammals that Gnaw." Here the beaver's skull is exhibited, with wood gnawed by the animals, as well as nuts opened by mice. For handling purposes one of the logs cut by a beaver is added. A more detailed series is that which shows the growth and structure of elephants' teeth. Features of a class generally are indicated by the hairs, spines, and scales under the title "The Covering of Mammals."

BIRDS.—The modifications of a particular structure throughout a class may be learnt from a collection, say, of beaks, of which quite a small one is put forward. Colours of birds' eggs and series of birds' nests will also illustrate the class as a whole; while another, dealing with the feeding of birds, follows up the same idea, and at the same time shows what results may be obtained, by means of crop contents, broken shells, and owl pellets, from material which at first sight may not look very promising.

Internal structure might be treated in the same way. The two classes illustrated already could have other external organs and habits represented; and the same ideas could be applied in the reptiles, amphibia, and fishes as well as to many of the invertebrate groups, where there are hard parts suitable for preservation. In some, a feature could be made of particular attributes, such as protective colouring. Very beautiful series of specimens could be arranged, illustrating the classification, say, of the mollusca and insects, as well as the life-histories of the latter.

(To be continued.)

REVIEWS.

ARTS.

The History of the Royal Society of Arts.—By SIR HENRY TRUEMAN WOOD. 558 pages. 31 plates. 19 figures. 9-in. × 6-in.

(John Murray. Price 15/- net.)

The Society of Arts has been in existence for nearly one hundred and sixty years, and during that time it has done so much work that it would be impossible to chronicle all that has been accomplished for the benefit of humanity, even if a large number of volumes were devoted to the record. From Sir Henry Trueman Wood's labour of love, which extends to more than five hundred and fifty pages, we may, however, get some idea of its activities: of its origin, of the eminent men connected with it at the beginning, of the way in which it has encouraged art, commerce, science, and manufactures, of the great exhibitions which it promoted, and of the examinations which it has held. As Lord Sanderson says in his preface, it came even to the Council as a revelation that the names of the elder Pitt, Lord North, Lord Rockingham, Lord Bute, and other historic Ministers of the time of George III were enrolled among its earliest members in somewhat uncongenial company with John Wilkes and Woodfall, the printer of the "Letters of Junius"; that Dr. Johnson is believed to have made, at one of its meetings, the only speech which he is known to have delivered on his legs; that Oliver Goldsmith was anxious to offer himself as a candidate for the post of Secretary, but was deterred by the refusal of Garrick to support him; and that the Society's efforts to introduce the bread-fruit tree into the West Indies led to Captain Bligh's expedition, which terminated in the mutiny of the "Bounty" and the colonisation of Pitcairn Island.

Not the least interesting part of the book is that which deals with the officials of the Society. The work which they have done is a tribute to their memory; but the present Secretary and author of the book has much praise for his predecessors, and he is himself to be greatly congratulated on his History of the Society of Arts, which he has written after more than thirty years of office.

W. M. W.

ASTRONOMY.

Milton's Astronomy.—By T. N. ORCHARD. 288 pages. 10 illustrations. 8½-in. × 5½-in.

(Longmans, Green & Co. Price 7/6.)

The author and publishers have produced an almost exhaustive volume upon the astronomical allusions of

England's noble poet, Milton, in "Paradise Lost." All who have the slightest interest in poetry or astronomy should certainly spare the time to read this book, written by a devoted student and critic of Milton's verse.

The book opens with a historical sketch of astronomy in fifty pages, dating from the Akkadian and Chinese races, and ends with the year of the death of Milton, 1674. In the second chapter, also of about fifty pages, the author treats of Milton's cosmology; Milton's use of such expressions as "chaos," "empyrean heaven," "mundane universe," "the Alphonsine system of the ten spheres"—the eighth being that of the stars, the ninth called the Crystalline Sphere, and the tenth the *Primum Mobile*—and the use of the Ptolemaic system as the base of Milton's poetic conceptions. The third chapter, as also the second, contains many quotations of the poet's verse: it goes fully into Milton's astronomical knowledge and his use of the older system instead of the Copernican system (about which at that time there was an embittered controversy) that had not then been generally accepted, though Milton perceived that its truth must prevail. The initial date of Milton's changed ideas of the universe the author puts as 1637-9, when Milton visited the Continent, made the acquaintance of Galileo and learnt the views of the great astronomers, Copernicus and Kepler, and was greatly aided by Galileo's actual observations and researches. Though the great epic was written twenty years later, Milton preferred his verse to be based upon the Ptolemaic system, as the one he had recognised in his earlier years, and as the one that still was almost universally held, and would be better understood in his poem. Many quotations are given as illustrations of Milton's views and uses of the Ptolemaic system, and of such astronomical terms as "meridian," "colure," "constellations," "ecliptic," and so on. An entertaining chapter is given of Milton's visit to Galileo in 1638, and Galileo's evident influence upon Milton's later views on astronomy. Chapters V and VI relate to Milton's frequent use of the seasons, the Sun, Moon, and stars; and the book is concluded with Chapters VII and VIII on Milton's references to familiar celestial objects, as Hesperus (Venus), Pleiades, Galaxy, comets, and meteors, and to descriptive astronomy.

Extensive introduction has been made of modern astronomical facts and discoveries, and their application as bearing upon Milton's allusions. Therefore, as already mentioned, this book should be read and used by all who have poetic fancy and love astronomy and England's great poet.

F. A. B.

BOTANY.

Plant Life in the British Isles.—By A. R. HORWOOD, F.L.S. 254 pages. 73 illustrations. 8-in. × 5-in.

(J. & A. Churchill. Price 6/6 net.)

Mr. Horwood's museum experience has told him that those who are to-day interested in living things are not content just to know the name of a plant or animal, and the points by which it may be identified, but that they wish to learn how, where, and when it grows. Mr. Horwood therefore takes a number of the better-known orders of British wild plants, illustrates them by means of excellent pictures by several skilled nature-photographers, and, while not neglecting the botanical side of the subject, introduces many points of general interest. In many cases we are told how the plant got its English name and what it is called locally. For instance, the wych elm was used for making chests called wyches, or hueches. In some places the teasel is known as "Venus's Belt," the primrose "Lady's Frills." Then, again, the uses of the plants are given. For instance, gruyère cheese owes its flavour to mellilot, the flowers and seeds of this being bruised and mixed with the curd before it is pressed. The groundsel in former days was employed in Scotland to keep off the evil eye. All these matters go to show that Mr. Horwood is not only thoroughly interested in his subject himself, but knows what will appeal to others. We foresee a cordial reception from the volume in hand, and for the later ones to which it is intended to be introductory.

W. M. W.

The Living Plant: A Description and Interpretation of its Functions and Structure.—By WILLIAM F. GANONG, PH.D. 478 pages. 3 coloured plates. 178 figures. 9-in. × 6¼-in.

(Constable & Co. Price 15/- net.)

Professor Ganong has tried to write a book which he would have been delighted to read himself when he was a learner, and we think that the way in which he has approached his subject will please those who are still learners. He discusses, first of all, the appeal which the study of plants makes to man; he then deals with that most important attribute of many plants, green coloration, and the work of building up food from inorganic sources in the presence of sunlight. Then we have the various activities shown by a plant considered in detail as they affect the individual. Next the way in which the individual is protected from harm occupies attention, before the question of the continuation of the species is described. Chapters are devoted to evolution, to plant breeding, and to classification. The whole structure of the book and its appearance is attractive, and we feel sure that the object which the author had in view has been satisfactorily accomplished.

W. M. W.

CHEMISTRY.

Underground Waters for Commercial Purposes.—By F. L. RECTOR, B.Sc., M.D. 98 pages. 8-in. × 5-in.

(Chapman & Hall. Price 4/6 net.)

This is an elementary book which gives a clear account of some of the scientific features in connection with the supply of water for industrial purposes and for municipal and public uses. It deals with the sources and properties of water, springs, and wells, and gives a brief outline of the principles of the chemical and bacteriological examination of water—not full enough for making an analysis, but sufficient to interpret the results. Regarded from the point of view of the manufacturer, the criticism may be made that the book does not deal with many of the problems that will occur. For example, the important question of the methods of softening water is dismissed in half a page, and no attempt is made to discuss the relative merits of the different chemical processes in use. In the bacteriological section there is no description of the effects of storage upon bacteria, or of chemical methods of sterilisation, such as the hypochlorite process, now extensively used in America. The bibliography includes only American authorities, and the list of these is by no means complete. The general reader will find much to interest him in the book, but those who wish to install their own water supplies will need to have recourse to larger manuals for much of their information.

C.A.M.

ENGINEERING.

Applied Mechanics for Engineers. By J. DUNCAN, WH.EX., M.I.MECH.E. 718 pages. 725 illustrations. 9-in. × 6¼-in.

(Macmillan & Co. Price 8/6 net.)

The worker in any branch of applied science soon learns the limitations of his laboratory experience when he has to deal with processes on a manufacturing scale. Problems present themselves for solution under quite different conditions from those to which he has previously been accustomed, and it is just at this point that text-books usually fail to afford any help. The author of this handbook fully recognises this, and rightly lays stress upon the importance of acquiring a sound knowledge of principles and

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of their application under varying conditions. No text-book can ever be made to obviate all difficulties that may occur, but the student who has mastered Mr. Duncan's book should seldom be at a loss. The first part deals with materials and structures, and includes such subjects as the strength of beams, columns, arches, bridges, springs, earth pressure, and so on, while in the second part, which is concerned with machinery and hydraulics, the various problems that will occur in connection with moving machinery are fully worked out and illustrated by excellent diagrams. Typical exercises to be done by the student in the laboratory are given, including those set in the examination for the B.Sc. (Eng.) of London University and other higher examinations in engineering; and there is an excellent index. No better introduction to the study of applied mechanics could be desired.

C.A.M.

Practical Science for Engineering Students.—By H. STANLEY, B.Sc., F.I.C., Lecturer in the Merchant Venturers' College, Bristol. 166 pages. 92 figures. 7-in. × 4½-in.

(Methuen & Co. Price 3/-.)

This book is stated to have been written primarily to suit the needs of evening students, who have passed the very elementary stages, and for those entering on an engineering training proper, who have not gone through a good course of laboratory work. It consists of descriptions of practical experiments in heat, mechanics, magnetism and electricity, and light, with short sections in which theoretical principles are briefly stated. The practical experiments described call for little remark. A final chapter dealing with the nature of some materials commonly found in engineering practice contains some inaccuracies. Thus in the section on iron occur the statements: "The Bessemer process can be stopped at any desired point. If one to two per cent. of carbon is still left, a steel is formed; but if only about 0·5 or one per cent. of carbon is left, ingot iron—a species of wrought iron or mild steel—is produced." In the preface the author states that a student's knowledge of engineering materials is often of the vaguest description. Such statements as those quoted will not only leave the student's ideas vague, but he will be actually misinformed.

T.S.

MOLLUSCA.

Monograph of the Land and Freshwater Mollusca of the British Isles.—By JOHN W. TAYLOR. Part 20. 410-480 pages. Plates XXVI-XXXIII. 471-552 figures.

10-in. × 6-in.

(Leeds: Taylor Bros. Price 7/6.)

Part 20 of Mr. Taylor's "Monograph" practically completes a volume. It contains a description of one of the more interesting of our larger land snails, *Helicigona arbustorum*, which is carried out in the same detail as in the case of other British species. We have never had any great sympathy with varietal names, though they serve to bring out many remarkable variations which are worthy of note. It is interesting that Mr. Taylor has found it necessary to divide the variations in the banding of the shell into two sections, the first of which includes atavistic forms in which the dark peripheral band is placed upon and within a broader, paler, and more or less calcified zone, while the second section includes varieties in which there are recognised differences in the pigmentation and the number of the bands.

The present part also contains an appendix, giving information which has been obtained since the publication of the earlier parts of the "Monograph" and a description of *Vitrina hibernica* detected by Mr. Taylor among material collected by Mr. T. H. Grearson, of Dublin, and described in 1907. The next part will contain the conclusion of the appendix, title page, and the index of the volume. Before concluding we should like to express our unstinted admiration of the coloured plates of *Helix nemoralis* and *Helicigona arbustorum*, which are among those issued with the part.

W. M. W.

PHOTOGRAPHY.

Practical Cinematography and its Applications.—By F. A. TALBOT. 262 pages. 93 illustrations. 7½-in. × 5-in.

(William Heinemann. Price 3/6 net.)

Apart from its present vogue as a method of amusement and its commercial aspect, cinematography is of very great importance in scientific work, while its use in education, though already recognised, needs still to be emphasised. A book dealing with the practical aspects of the matter is therefore very much to the point at the present moment. We may pass over the financial side and point out that Mr. Talbot gives some valuable chapters on the use of the camera, and on developing the film, as well as on printing positives. His hints, though brief, with regard to cinematography with the microscope may be mentioned. We feel, however, that an improvement might be made in the title "Micro-Cinematography" which he gives to the chapter. We think that as a picture taken with a microscope is called a photo-micrograph some such word as "cine-micrograph" would be much better than micro-cinematograph. Radio-cinematography is also touched upon, and even the ultra-microscope. Mr. Talbot says, with regard to the educational films, that the attitude of responsible authorities is unfortunately lukewarm, and he gives a good reason, namely, that the producer looks upon the question only from a showman's point of view, but this ought to be easily remedied. Lastly, Mr. Talbot advocates the establishment of national cinematograph laboratories, and no doubt as time goes on we shall see these come into being.

W. M. W.

Handbook of Photo-Micrography.—By H. LLOYD HIND, B.Sc., and W. BROUGH RANDLES, B.Sc. 292 pages. 44 plates. 71 figures. 9-in. × 5-in.

(George Routledge & Sons. Price 7/6 net.)

This book gives a very clear description of the various pieces of apparatus used in photographing through the microscope, and also deals with low-power photo-micrography where photographic lenses of small focal length are used without a microscope. We recommend the work as one of reference to those who want to take up the subject with which it deals. The excellent illustrations, some of which are in colour, serve to show the work that can be done by the methods described.

W. M. W.

PSYCHOLOGY.

Minds in Distress.—By A. E. BRIDGER, B.Sc., M.D., F.R.S. 177 pages. 7¾-in. × 5-in.

(Methuen & Co. Price 2/6 net.)

This book is an exceedingly interesting one, particularly on account of the way in which it deals with what the author terms the masculine mind and the feminine mind, which may be possessed to considerable extent by either sex. Of the two main classes of educated people Dr. Bridger says one is very practical, demanding proof before a conclusion is accepted and relying only on facts; the other lives in a different plane of thought altogether, asserting that the effect will be so and so, seeing the end to be attained, little concerned with the process by which it is reached, and devoted to ideas. Among the former (with the masculine type of mind) are those steady, plodding people who achieve financial success or at least stability; among the latter (with the feminine type of mind) are the brilliant, artistic, creative, and spiritual. The genius is of the latter class. The bulk of the book is concerned with the aberrations of the normal types of mind, and is well worth the attention of the scientific and general reader.

W. M. W.

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NOTICES.

SUPPLEMENT TO THE "INDEX KEWENSIS."—The Clarendon Press announces that the fourth supplement to the "Index Kewensis," dealing with the years 1906-10, is now ready.

MOTORS STARTED WITH A PUSH-BUTTON.—The Igranic Electric Company has sent us an illustrated pamphlet showing how motors can be controlled by electric push-buttons, which start, accelerate, retard, or stop them. The amount of space that may be saved in the neighbourhood of machines is considerable, for the control gear can be put in a more convenient place.

SPECTROPHOTOMETERS.—Messrs. Adam Hilger, Limited, have published a Bibliography concerning the chemical significance of absorption spectra, which we have pleasure in commending to our readers. Organic compounds and rare earths are dealt with, and the apparatus required for spectrophotometry in the ultra-violet, visible, and infra-red regions is described and illustrated at the end of the booklet.

MINERALS AND THE MICROSCOPE.—Messrs. Murby and Company announce the publication of an introduction to the study of petrology, which has been written by Mr. J. T. Smith, Demonstrator in Geology in the Imperial College of Science, under the title of "Minerals and the Microscope." The aim is to help the student in early difficulties rather than to give him long lists of facts.

NEW BOOKS ON PHYSICS AND CHEMISTRY.—Messrs. J. & A. Churchill will shortly publish the two following new works: "Molecular Physics," by J. A. Crowther, Demonstrator in Physics, Cavendish Laboratory, Cambridge; and "The Synthetic Use of the Metals in Organic Chemistry," by A. J. Hale, Demonstrator, City and Guilds of London Institute, Technical College, Finsbury.

THE LONDON ASTRONOMICAL SOCIETY.—The London Astronomical Society in its circular points out the urgent need for a London astronomical museum. The Society was established to correlate astronomic facts, and on this basis consistent cosmology groups have been established with the following objects: (1) To collect from all parts further facts confirming deductions; (2) to promote fellowship amongst those interested in astronomy and allied sciences; (3) to make practical use of the lessons learnt.

FLOATING BODIES.—The study of equilibrium and floating bodies is a very interesting one, and Messrs. Constable & Company announce that they are about to publish a book on the subject by Mr. B. C. Laws. That it will be of an essentially practical character is shown by the fact that it contains chapters on the stability of ships, floating docks, submarines, and aërial machines. Caissons also come in for attention. The book is intended to be helpful, not only to the student, but to the naval architect in engineering practice.

FOLK-LORE.—In the March number of *The Irish Naturalist* there is a paper by Mr. Nathaniel Colgan on "Field Notes on the Folk-lore of Irish Plants and Animals." One interesting point brought out is the doctrine of sexes in plants, which is upheld all over Ireland. We will give one instance, namely, of the He- and the She-Bulkishawn. Mr. Colgan's informant was a car-driver. The He-Bulkishawn was the rag weed. The She-Bulkishawn—an ingredient in a famous horse medicine—which the driver said was very difficult to find, turned out to be the common tansy.

ZOÖLOGICAL GARDENS OF THE WORLD.—Captain S. S. Flower, the Director of the Zoölogical Gardens of Giza, has kindly sent us the reference list of zoölogical gardens of the world which he annually compiles. There are at present one hundred and seventy-five, the total being made up as follows: Africa, 13; North America, 57; South America, 10; Asia, 27; Australasia, 8; Europe, 60. In many cases the date of the foundation is given and the name of the Superintendent.

CUMBERLAND NATURE RESERVE ASSOCIATION.—The Cumberland Nature Reserve Association, of which the Speaker is President and Major Spencer Ferguson (Mayor of Carlisle) is the Chairman, has now started active work, and is raising a fund to provide keepers or watchers for reserves which it is establishing in the county. Contributions will, if desired, be earmarked for the special protection of the Peregrine Falcon, the Buzzard, and the Raven. The Secretary is Mr. Linnaeus E. Hope, of the Municipal Museum, Carlisle.

THE BIRD-LOVER.—The Brent Valley Bird Sanctuary Committee has issued the first number of an occasional paper, entitled *The Bird-Lover*, which contains articles on "Nesting Boxes," with hints as to how they should be chosen and put up, on "Bird Watching," and other matters of interest to those who are fond of birds. Illustrations and prices of all the types of nesting boxes designed and supplied by the Committee are also given. *The Bird-Lover* (price 6d.) can be obtained from the Secretary of the Committee, Odstock, Hanwell, London, W.

THE JOURNAL OF THE BOARD OF AGRICULTURE.—In the March number of this publication Mr. C. S. Salmon gives a detailed article on spraying experiments on the American gooseberry mildew. Mr. George Massee describes a new disease of narcissus bulbs which is becoming troublesome; and another interesting communication deals with the poisoning of cows through their eating *Rhododendrum ponticum* and its hybrids. Sir Joseph Hooker, in his "Himalayan Journals," records that many of his goats and kids died through eating the leaves of *Rhododendrum cinnabarinum*, which in his day was supposed to be the only poisonous species.

THE WEATHER AT TOTLAND BAY.—The fourteenth annual report on the Meteorological Observations made during the past year at Aston, Totland Bay, Isle of Wight, has been sent to us by the compiler, Mr. John Dover. One of the points about the station is the marked absence of thunderstorms; and, although the rainfall of over thirty-one inches places 1913 among the wet years of Totland, from May 30th to August 30th the total rainfall in ninety-three days was only 1·93 inches. Turning to the temperature, gooseberries were in full bloom on February 19th, and blackberries on December 28th. The brightest day was June 30th, with fifteen hours of bright sunshine.

AMENDMENT OF THE PATENT AND DESIGNS ACT.—Mr. Walter F. Reid, the Chairman of the Institute of Inventors, writes from 20 High Holborn, London, the following letter, which we are pleased to print:—

"As your readers are aware, the amendment of the Patent and Designs Act is now under the consideration of Parliament.

We have already received a number of valuable suggestions from our Fellows on the subject; but as the Institute represents inventors generally we shall be obliged if you will afford us the opportunity of appealing to all those interested who have not yet communicated their views to us."

XUM

THE SCOTTISH NATIONAL ANTARCTIC EXPEDITION.—A very strongly supported memorial has just been sent to the Prime Minister, asking for a grant of £3800 from the Treasury towards the completion of the publication of "The Scientific Results of the Voyage of the 'Scotia' to the Antarctic Regions, 1902, 1903, and 1904," by the Scottish National Antarctic Expedition Committee.

Taking into consideration the amount of money given by the Government towards the cost of the Shackleton and Scott expeditions, it is to be hoped that the application will be successful; for there is no doubt that most valuable scientific results have been obtained, and it is only right that they should be published.

SOCIOLOGY.—We have received from the Sociological Society a prospectus of "Interpretations and Forecasts: A Study of Survivals and Tendencies in Contemporary Sociology," by Victor Branford, M.A. (Duckworth). Its review of social and economic movements, and its attempt to give a sociological interpretation of them detached from partisan points of view and political interests, are in continuation of the author's work for the advancement of sociological science as one of the founders of the Sociological Society and its first Honorary Secretary. The author has made arrangements with his publisher by which the profits of the English edition will be for the benefit of the Cities Committee of the Sociological Society, and consequently the Society is interested in making the book widely known for this purpose as well as for the general advancement of the science.

PSEUDO-SCORPIONS. — At the meeting of the Zoölogical Society, held on March 3rd, Mr. H. Wallis Kew read a paper on the building and spinning by Pseudo-Scorpions of the nests in which these animals enclose themselves for moulting, for brood-purposes, and in some cases for hibernation. They are closed cells of spun tissue with or without a covering of earthy or vegetable matters. The tissue is of innumerable threads crossed and coalesced irregularly, without interspaces, and almost like silk-paper. With regard to the spinning apparatus, confusion has existed; but Mr. Kew's observations on living animals place it beyond doubt that the cephalothoracic glands, whose ducts traverse the chelicerae to near the apex of the movable finger and open in the galea, or in the tubercle which replaces it in some groups, are the organs concerned. Contrary to previous statements, the "combs" of the chelicerae have nothing to do with the silk.

MUTTON BIRDS.—At a meeting of the Field Naturalists' Club of Victoria, held in 1912 (see *The Victorian Naturalist*, March, 1912, page 206), Mr. Joseph Gabriel spoke of the exaggerated accounts of so-called cruelty to the Mutton Birds of Phillip Island, and pointed out that the presence of barbed-wire fencing was the primary cause of the numerous deaths and woundings of the birds. Two members questioned the statement, and said that the dead birds, having been found lying in heaps, were evidence of cruelty, and that large quantities of bones scattered about pointed to former slaughter. In the January number of *The Victorian Naturalist* Mr. Gabriel clears the matter up. The heaps of birds, he says, were all young ones, killed outright in order to obtain "beak oil," which is used medicinally. In the second place, a drift of sand took place some years ago at the rookeries, which covered up a number of the holes and smothered the nesting-birds. Recently the sand has drifted in the opposite direction, laying bare the old rookeries and the bones of the dead birds.

WIRELESS TELEGRAPHY.—Mr. G. Marconi delivered a lecture in Rome on March 3rd before the King and Queen of Italy and both Houses of Parliament. He described the progress which had been made in wireless telegraphy, and the difficulties which had been overcome since his previous lecture in Rome in 1903. His voyage to South America on board the "Principessa Mefalda" had illustrated that communication in a north and south direction was easier than communication in an east and west direction. Mr. Marconi described his new system for generating continuous waves, and its use in wireless telephony. He then described the apparatus for producing waves, divided into regular groups, and dealt with the improvements effected in receivers, giving a practical demonstration of the reception of messages in the lecture hall, from Poldhu, in Cornwall and Tripoli. Mr. Marconi finally described the practical applications of radiotelegraphy to all types of vessels, including submarines, as well as its uses in war and peace. He concluded with an acknowledgment of the help which he had received from the King and Queen of Italy.

CRIMINAL ANTHROPOLOGY. — Mr. Arthur MacDonald, of Washington, is advocating in America the establishment of laboratories—using the word in the widest sense—for the study of the criminal, pauper, and defective classes. He thinks that there is no necessity for so much crime as at present exists, and that there should be a thorough scientific investigation of the whole subject of criminal man. Mr. MacDonald has written to the Home Secretary in England pointing out that his plan does not involve great expense; that a bureau for moral, is even more necessary than one for physical, health; and that, although public interest in his work has increased greatly, very little has been done on the scientific side of the subject. He suggests for a practical beginning that a few young men with psychological, medical, and anthropological training should first study the inmates (especially the young) of our penal and reformatory institutions. One of the main objects should be to investigate the causes of crime; then, from the knowledge gained, a rational basis could be furnished for methods of reform. We should very much like to see some action taken in this country in the direction indicated. Mr. MacDonald, who was the President of the Third International Congress of Criminal Anthropology (of Europe), writes from "The Congressional," Washington. He has prepared an interesting pamphlet, entitled "The Study of Man," which sets forth his views, and a list of the public documents which he has written bearing on the subject (to be obtained from the Superintendent of the Senate Document Room) is given on the cover.

THE ROYAL INSTITUTION.—The following are the lecture arrangements at the Royal Institution after Easter: Dr. Walter Wahl, two lectures on "Problems of Physical Chemistry": (1) "Study of Matter at High Pressures"; (2) "Structure of Matter at Low Temperatures" (experimentally illustrated). Professor W. Bateson, Fullerian Professor of Physiology, Royal Institution, two lectures on (1) "Double Flowers"; (2) "The Present State of Evolutionary Theory." Professor D'Arcy W. Thompson, two lectures on "Natural History in the Classics": (1) "The Natural History of the Poets: Homer, Virgil, and Aristophanes"; (2) "The Natural History of Aristotle and of Pliny." Professor A. Fowler, two lectures on "Celestial Spectroscopy: Experimental Investigations in Connection with the Spectra of the Sun, Stars, and Comets." Three Literary Lectures. Professor Svante Arrhenius, three lectures on "Identity of Laws in General and Biological Chemistry." Professor Silvanus P. Thompson, two lectures on "Faraday and the Foundations of Electrical Engineering." Dr. T. E. Stanton, two lectures on "Similarity of Motion in Fluids": (1) "The Theory of Similarity of Motion in Fluids and the Experimental Proof of its Existence"; (2) "The General Law of Surface Friction in Fluid Motion." Professor C. J. Patten, two lectures on "Bird Migration." Professor J. W. Gregory, two lectures on (1) "Fiords and their Origin"; (2) "Fiords and Earth-movements." Mr. Sigismund Goetze, two lectures on "Studies on Expression in Art"; (1) "Origin and Development"; (2) "Right Expression in Modern Conditions." The Friday evening meetings will be resumed on April 24th, when the Astronomer Royal, Mr. F. W. Dyson, will deliver a discourse on "The Stars Around the North Pole."